EXPOSURE ASSESSMENT MEMORANDUM
SAN JACINTO RIVER WASTE PITS SUPERFUND SITE

Prepared for

McGinnes Industrial Maintenance Corporation
International Paper Company
U.S. Environmental Protection Agency, Region 6

Prepared by

Integral Consulting Inc.
411 1st Avenue S, Suite 550
Seattle, Washington 98104

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LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
95UCL	95 percent upper confidence limit on the mean
ADD	average daily dose
BEHP	bis(2-ethylhexyl)phthalate
BHHRA	baseline human health risk assessment
COPC	chemical of potential concern
$COPC_H$	chemical of potential concern to be addressed in the baseline human health risk assessment
CSM	conceptual site model
CT	central tendency
CTE	central tendency exposure
CWA	Coastal Water Authority
DQO	Data Quality Objective
EAM	Exposure Assessment Memorandum
EPC	exposure point concentration
FCA	fish collection area
IPC	International Paper Company
LADD	lifetime average daily dose
MIMC	McGinnes Industrial Maintenance Corporation
MWW	Mann Whitney Wilcoxon
NHANES	National Health and Nutrition Examination Survey
OEHHA	Office of Environmental Health Hazard Assessment
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-*p*-dioxin
PCDF	polychlorinated dibenzofuran
PRA	probabilistic risk assessment
PSCR	Preliminary Site Characterization Report
RBA	relative bioavailability adjustment
RI/FS	Remedial Investigation and Feasibility Study

RM	reasonable maximum
RME	reasonable maximum exposure
ROS	regression on order statistics
SALG	Seafood and Aquatic Life Group
SAP	Sampling and Analysis Plan
Site	San Jacinto River Waste Pits site in Harris County, Texas
SJRWP	San Jacinto River Waste Pits
SWAC	surface weighted average concentration
TCEQ	Texas Commission on Environmental Quality
TCRA	Time Critical Removal Action
TDSHS	Texas Department of State Health Services
TEF	toxic equivalency factor
TEQ	toxicity equivalent
TEQ_{DF}	toxicity equivalent for dioxins and furans
TEQ_{DFP}	cumulative toxicity equivalent for PCBs and dioxins and furans
TEQ_{P}	toxicity equivalent for polychlorinated biphenyls
TMDL	total maximum daily load
TOC	total organic carbon
UAO	Unilateral Administrative Order
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service

1 INTRODUCTION

This technical memorandum was prepared on behalf of International Paper Company (IPC) and McGinnes Industrial Maintenance Corporation (MIMC; collectively referred to as the Respondents) in fulfillment of the 2009 Unilateral Administrative Order (2009 UAO), Docket No. 06-03-10, issued by the U.S. Environmental Protection Agency (USEPA) to IPC and MIMC on November 20, 2009 (USEPA 2009a), for the San Jacinto River Waste Pits (SJRWP) site in Harris County, Texas (the Site). The 2009 UAO directs the Respondents to perform a Remedial Investigation and Feasibility Study (RI/FS) for the Site, and to prepare a Baseline Human Health Risk Assessment (BHHRA). The UAO also directs respondents to prepare an Exposure Assessment Memorandum (EAM) prior to the BHHRA report to describe the exposure scenarios, assumptions, fate and transport models, and data that will be used in the exposure analysis.

This document fulfills the UAO requirement for the EAM, establishing the methods, assumptions and data that will be used to perform the human exposure assessment. It builds on the conceptual site models (CSMs) described in the Preliminary Site Characterization Report (PSCR) (Integral and Anchor QEA 2012) for the impoundments north of I-10 and surrounding aquatic environments (Figure 1) and the impoundment south of I-10 (Figure 2). Consistent with UAO requirements and the RI/FS Work Plan (Anchor QEA and Integral 2010), the specific topics addressed by this EAM include:

- Exposure pathways and scenarios to be addressed in the BHHRA
- Datasets and methods to be used for calculation of exposure point concentrations (EPCs)
- The exposure equations and assumptions to be used
- Considerations for application of probabilistic methods to the exposure assessment.

The RI/FS Work Plan also states that the EAM will provide summary statistics for each dataset to be used in the BHHRA, and calculate EPCs for each exposure medium. Summary statistics for individual datasets for which data are available are presented in the PSCR (Integral and Anchor QEA 2012). EPCs are not presented in this EAM but will be prepared following USEPA review and approval of this document, which is a complete presentation of the data and all of the methods and assumptions that will be used to derive EPCs.

1.1 Site Setting

The Site consists of three impoundments, built in the mid-1960s for disposal of paper mill wastes, and the surrounding areas containing sediments and soils potentially contaminated with the waste materials that were disposed of in these impoundments. Two impoundments, together approximately 14 acres in size, are located on a 20-acre parcel immediately north of the I-10 Bridge and on the western bank of the San Jacinto River (Figure 3). Historical documents and aerial photographs indicate that an additional impoundment was constructed south of I-10, on the peninsula of land south of the 20-acre parcel. This impoundment was also constructed in the mid-1960s. It was used for disposal of paper mill waste similar to that disposed in the two impoundments north of I-10, and other anthropogenic wastes. Figure 3 shows the area within USEPA's preliminary Site perimeter, as presented in the 2009 UAO, with the specific area for the soil investigation south of I-10 noted.

A Time Critical Removal Action (TCRA) to address soils and sediments associated with the impoundments north of I-10 has been completed. Through the installation of geotextile and geomembrane underlayments and a granular cover, the TCRA stabilized the entire area within the 1966 perimeter of the impoundments north of I-10 (the TCRA Site) (Figure 3), abating any release of polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and any other chemicals of potential concern (COPCs) into the waterway from these impoundments until the Site is fully characterized and a final remedy is selected (USEPA 2010a). Fencing installed as part of the TCRA implementation additionally limits access to the impoundments north of I-10, areas to the immediate west of these impoundments, and the eastern shore of the San Jacinto River immediately adjacent to I-10. The Coastal Water Authority (CWA) also installed fencing along the western side of the road to the immediate east of the Site that limits access to the shoreline on the east side of the channel under the I-10 Bridge. The placement of fences is shown in Figure 4. The condition that resulted from the TCRA and the installation of fencing by CWA collectively are described in this document as the "post-TCRA" condition.

1.2 Purpose and Scope

This memorandum is intended to establish an approved set of methods and assumptions that will be used for quantifying potential exposures in the BHHRA. The approaches and methodologies presented in this EAM are consistent with Data Quality Objectives (DQOs) and related statements and information presented in the sediment, tissue and soil sampling and analysis plans (SAPs) for the Site (Integral and Anchor QEA 2010; Integral 2010a,b), and the RI/FS Work Plan (Anchor QEA and Integral 2010).

Comments from USEPA on this draft EAM will be incorporated into a final EAM that will ultimately be included as an appendix to the draft BHHRA Report, which is scheduled to be submitted to USEPA in July 2012. Ultimately, the methods and assumptions outlined and discussed in the final EAM will be used to estimate intakes of chemicals of potential concern to be addressed in the BHHRA (referred to as $COPC_{HS}$ herein) that will subsequently be combined with toxicity criteria to derive estimated risks and hazards at the Site. Toxicity criteria are discussed in detail in the Toxicological and Epidemiological Studies Memorandum (Integral 2012), which is under development on the same schedule as this document.

USEPA guidance requires that a remedial investigation include evaluation of baseline risks to human receptors. In this context, "baseline" refers to the conditions at the site before implementation of the remedy. As such, baseline conditions provide a point of reference for evaluation of the no-action alternative in the feasibility study, and for quantification of risk reduction that can be achieved by each of several remedial alternatives to be considered in the feasibility study. The "baseline" condition to be evaluated by the risk assessments is the pre-TCRA condition.

The implementation of the TCRA and installation of fencing by CWA, which occurred after the sediment and tissue sampling programs had been completed, has greatly limited access to the area, and significantly altered exposure potential for all of the human receptors to be addressed in the BHHRA. Therefore, whenever relevant, analysis of exposure and risk will recognize both pre-TCRA and post-TCRA conditions. Evaluating the differences in risk between the pre-TCRA (baseline) and post-TCRA conditions is necessary for a complete analysis of costs and benefits associated with each of the remedial alternatives considered by the feasibility study in development of the final remedy.

The evaluation of post-TCRA conditions will prioritize the analysis of dioxins and furans, which have been established as an indicator chemical group for the Site (Anchor QEA and Integral 2010). An indicator chemical or chemical group is one that is the most toxic, persistent, and/or mobile among those substances likely to contribute significantly to the overall risk at a site (USEPA 1988). USEPA (1988) guidance recognizes that the use of a properly selected indicator chemical or group reduces both the time and costs of developing remedial approaches. As summarized in Appendix C of the RI/FS Work Plan, concentrations of dioxins and furans relative to risk-based screening values are very high in sediments from the impoundments north of I-10, and the degree to which they exceed risk-based screening levels in these sediments relative to those of the other COPCs is also very high, indicating that they are very likely to be the most important risk driver at the Site. Therefore, the focus on dioxins and furans for the post-TCRA evaluation will enable description of the differences between pre-TCRA (baseline) and post-TCRA exposure potential.

1.3 Document Organization

USEPA (1989) defines three main steps to the exposure assessment process:
1) characterization of the exposure setting, 2) identification of exposure pathways, and
3) quantification of exposure. The first two components of this process have been addressed and are presented within documents related to the RI/FS being conducted for the Site. These are summarized in Section 2. The third step will be performed for the BHHRA, according to methods described in Sections 2 through 5.

This document is organized as follows:

- Section 2. Exposure pathways and scenarios
- Section 3. Datasets and methods used for calculation of EPCs
- Section 4. Exposure equations and parameters
- Section 5. Implementation of probabilistic exposure assessment
- Section 6. Summary
- Section 7. References.

It also includes the following appendices:

- Appendix A. Quality Assurance Review, PCB Congener Data from the TMDL Program
- Appendix B. Historical Fish Tissue Data
- Appendix C. Results for Statistical Comparisons of FCAs
- Appendix D. Detection Frequencies for Sediment, Tissue, and Soil Exposure Units
- Appendix E. Contribution of Individual Dioxin Congeners to TEQ_{DF} in Tissue.
- Appendix F. EPA Comments Relating to the Draft Exposure Assessment Memorandum, and Responses

2 EXPOSURE PATHWAYS AND SCENARIOS

Consistent with the RI/FS Work Plan (Anchor QEA and Integral 2010) and the PSCR (Integral and Anchor QEA 2012), the exposure assessment will be based on two CSMs. A CSM describes the sources, release mechanisms, distribution and transport pathways of chemicals to potential receptors. Exposure pathways link sources of COPCs to potential receptors and define those links in terms of specific exposure routes; an exposure route is the physical way in which human receptors may come into contact with chemicals present in exposure media (i.e., ingestion, dermal absorption, inhalation). Exposure pathways are considered potentially complete and significant if the exposure occurs frequently over an extended duration and/or the exposure medium represents a significant potential source of site-related contaminants to the receptor. Exposure pathways are considered potentially complete but minor if the exposure medium represents a relatively minor potential source of site-related exposure to a chemical, and/or potential for contact to the medium is limited. The relative importance of each pathway and route is relevant because pathways that are considered potentially complete and significant are those that provide the greatest risk reduction when addressed by remedial action.

This section reviews the two CSMs for the Site and describes the exposure scenarios and pathways to be addressed in the BHHRA. One CSM describes the area north of I-10 and includes the aquatic environment (Figure 1). The other describes the area of the south impoundment (Figure 2). As described in the RI/FS Work Plan (Anchor QEA and Integral 2010), exposure pathways that are potentially complete and significant will be evaluated quantitatively.

Exposure pathways that are defined as potentially complete but minor will be evaluated qualitatively in the BHHRA. The manner in which minor pathways will be discussed is described below.

Data and methods for quantifying exposures to complete and potentially significant pathways are described in Sections 3 and 4 below.

2.1 Area North of I-10 and Aquatic Environment

In addition to the overall Site CSM, a detailed description of the expected exposure routes are shown in Figure 5 for each of the receptors, fishers, recreational visitors, and trespassers. The receptors shown in this CSM have been identified as those with potentially complete exposure pathways for the area north of I-10 and the aquatic environment (Anchor QEA and Integral 2010; Integral 2011a). The following potential exposure routes are identified in the CSM exposure diagram for human receptors for the area north of I-10 and aquatic environments (Figure 5):

- Ingestion of and dermal contact with chemicals in sediments
- Dermal contact with chemicals in porewater
- Ingestion of and dermal contact with chemicals in surface water
- Ingestion of fish and shellfish
- Ingestion of and dermal contact with chemicals in soils
- Inhalation of chemicals in air (i.e., gases or particulates).

For the fishers and recreational visitor, potentially complete and significant exposures to Site media are expected to occur via direct contact with sediments or soil (via ingestion and dermal contact) and, for the fishers, also through ingestion of aquatic organisms (i.e., fish and shellfish) that contain Site-related contaminants. While a Site trespasser would be exposed via the same pathways as the recreational visitor (i.e., direct contact pathways) and recreational fisher (i.e., ingestion of fish and shellfish), the trespasser exposure would likely be intermittent and shorter term than the exposures being evaluated for those scenarios. These pathways are considered to be minor pathways in the CSM. Therefore, this scenario will not be evaluated in a quantitative manner for the area north of I-10. A discussion of the exposure that would be anticipated for the trespasser relative to exposures calculated for the recreational visitor and recreational fisher will be included in the BHHRA.

Individuals may also be exposed to COPCs through direct contact (ingestion and dermal) with surface water and sediment porewater, or through inhalation of COPCs as particulates or vapors in air, but exposures via these media and routes are considered to be minor. For pathways leading to inhalation exposure, designation as minor is consistent with standard exposure assumptions used for determining residential and industrial soil screening levels, for which inhalation contributes less than 1 percent of the total exposure via all direct pathways (including ingestion via soil and dermal contact with soils) to the nonvolatile COPCHS present at the Site (USEPA 2011a). Moreover, the Draft Public Health Assessment for the Site (TDSHS 2011) also considered direct exposure to surface water and inhalation of COPCHS in air to be minor pathways.

Consistent with the RI/FS Work Plan (Anchor QEA and Integral 2010), minor pathways will be discussed qualitatively in the BHHRA. This discussion will use information about the physical-chemical properties of the COPCs to describe the likely extent of their presence in media for which exposures are considered minor. Evaluation of minor pathways will also include a description of the likelihood, frequency, and intensity with which exposures via minor pathways and routes are anticipated to occur at the Site for each receptor. Relevant information from the peer-reviewed literature and risk assessments from other sites, if available, will also be summarized. These lines of evidence will be combined to define the importance each minor pathway relative to the pathways defined as potentially complete and significant.

2.2 South Impoundment Area

The area south of I-10 is developed and managed for commercial and industrial activity. Industrial workers and trespassers are the human receptors with potential for exposure in this area (Integral 2011b). The following potential exposure routes for human receptors are considered in the CSM exposure diagram for human receptors for the south impoundment area (Figure 6):

- Ingestion of and dermal contact with chemicals in soils
- Inhalation of chemicals in air (i.e., gases or particulates).

Potentially complete and significant exposures for workers and trespassers to Site media in the south impoundment area are expected to occur via direct contact with soil (via ingestion and dermal contact). As presented above for the north impoundment area, exposures via inhalation are considered to be minor, and will be discussed qualitatively.

3 DATASETS AND METHODS FOR CALCULATION OF EXPOSURE POINT CONCENTRATIONS

CERCLA guidance (USEPA 1988) states that a baseline risk assessment is performed to identify the existing or potential risks at a site, support a determination of whether remediation is needed, and serve as the basis for the evaluation of the effectiveness of any subsequent remedial action. Determination of an appropriate baseline dataset is therefore a key step in the RI/FS process.

Characterization of the background condition provides context to the evaluation of onsite conditions. The background dataset effectively represents the exposure condition in the absence of contributions from a site. Comparison of onsite and background-related exposure allows evaluation of the additional, incremental exposure and risk presented by chemicals of concern that are attributable to a site. For chemicals with high background concentrations, characterization of background exposures and risks is recommended by USEPA (2002a) if data are available.

To organize the baseline dataset for use in exposure assessment according to specified exposure scenarios, exposure units are identified, and EPCs are calculated for each exposure medium within each exposure unit. An exposure unit is defined as the area throughout which a particular receptor moves and encounters an environmental medium for the duration of the exposure (USEPA 2002b). An EPC is a conservative estimate of the chemical concentration in an environmental medium (USEPA 1989, 2002b) that may be contacted by the human receptor. In human health risk assessment, the EPC may be represented as the central tendency (CT) of the dataset for an exposure unit, or as the reasonable maximum (RM) concentration. In either case, the CT or RM concentration is calculated using a statistic that is appropriate to the distribution of the data (e.g., maximum or 95 percent upper confidence limit on the mean [95UCL] for the RM). EPCs are determined for individual exposure units within a site.

This section first identifies the $COPC_{HS}$ to be addressed, the baseline data to be used for the BHHRA, and the dataset to characterize the background exposure conditions, and the data treatment rules that will be applied to the data. Next, it presents the methods for the analyses used to define the medium-specific exposure units, and results of that evaluation. Finally, it presents the methods that will be used to calculate EPCs for each individual exposure unit.

3.1 Chemicals of Potential Concern

$COPC_{HS}$ have been identified according to steps described by the RI/FS Work Plan (Anchor QEA and Integral 2010) and the Sediment SAP (Integral and Anchor QEA 2010). Analyses of the sediment data according to methods described in the Sediment SAP are documented in the COPC Technical Memorandum (Integral 2011a) and resulted in determination of the final list of $COPC_{HS}$ for the area north of I-10 and the aquatic environment (Table 1). Selection of $COPC_{HS}$ for the south impoundment area is in progress. According to a comparison of the Phase I soil investigation results to risk-based human health screening levels protective of workers, only detected TEQ_{DF}, arsenic, and thallium exceeded screening concentrations in any surface and subsurface samples for which they were analyzed (Integral 2011c, Attachment A).[1] Although thallium is not a $COPC_{H}$ according to analyses of information for the north impoundment, it may be determined to be a $COPC_{H}$ for the south impoundment, and is therefore addressed in this memorandum and listed in Table 1. Any COPC (see Table 2) in addition to those in Table 1 that becomes a $COPC_{H}$ for the south impoundment and impact the content of this EAM will be addressed as an attachment to the final EAM, which will be an appendix to the BHHRA Report.

3.2 Data

To evaluate the potential exposure via pathways outlined in the two CSMs, data for sediment, fish and shellfish tissue, and soils are required. Identification and organization of representative data for calculation of EPCs for the BHHRA involves determination of the baseline dataset for the Site and the dataset to be used to represent background conditions. Selected data should be representative of the sediment, soils, and tissue to which people may be exposed.

[1] Total PCB concentrations were calculated as the sum of Aroclors with nondetects substituted at one-half the detection limit. High-biasing nondetects, or those results for which the detection limit was greater than the maximum detected concentration, were excluded from the analysis. Both of these steps are consistent with the data management plan for this Site (see Appendix A of the RI/FS Work Plan) and consistent with the data treatment rules established in the PSCR, and outlined in Section 3.3 below.

Available data to be used in the BHHRA to evaluate exposure are summarized in Table 3 and discussed below. The determination of the specific exposure scenarios and pathways for which background risk calculations will be conducted will depend on the results of the assessment of Site-related risks. For this memorandum, the complete set of available background data that may be considered for quantitative evaluations within the BHHRA is presented, even though background risks may not be relevant for all media. This section first describes the datasets to be used for both the Site-related and background exposure assessments. A description of the data types to be used follows. The specific data that will be used to evaluate each exposure pathway under each exposure scenario are described in Section 4 in the context of the individual receptor groups.

3.2.1 *Baseline Risk Assessment Datasets*

The PSCR establishes the baseline dataset for the Site, and related information is reviewed below. This memorandum adds to the baseline dataset discussed in the PSCR by addressing tissue and sediment samples collected by the Texas Commission on Environmental Quality (TCEQ) in 2008 and 2009 and analyzed for polychlorinated biphenyls (PCBs). Background data for use in the baseline risk analyses are also discussed in this section.

3.2.1.1 Baseline Data for the Site

According to the PSCR and CERCLA guidance (USEPA 1988), data used in the baseline risk assessment should represent current conditions. Because risk management decisions will stem from the baseline risk assessment, the data used should also be of known and acceptable quality. As described in the RI/FS Work Plan (Anchor QEA and Integral 2010), Category 1 data are of known quality and are considered to be acceptable for use in decision-making for the Site, and only Category 1 data will be considered for quantitative risk analysis in the BHHRA.

A comparative analysis of the 2005 and 2010 surface sediment data from the area surrounding the northern impoundments is presented in Section 3 of the COPC Technical Memorandum (Integral 2011a). The analysis demonstrated that there were significant differences in dioxin and furan concentrations in surface sediment between 2005 and 2010. It concluded that the sediment data from 2005 was not representative of current conditions, and that it should therefore not be included in the baseline dataset. Although the cause of the difference is unknown, this analysis provided a useful benchmark for all of the datasets, assuming that changes in sediment conditions also represent changes in overall conditions for other media. On this basis, the PSCR establishes that none of the data collected in 2005 or earlier should be considered part of the baseline dataset.

The draft PSCR indicates that additional data recently generated by TCEQ's Total Maximum Daily Load (TMDL) program for PCBs will be included in the BHHRA if the data can be independently validated, as prescribed by Section 3 of the RI/FS Work Plan. Following publication of the draft PSCR, additional data for PCB congeners in tissue and sediment collected both on the Site and elsewhere as part of TCEQ's TMDL program (University of Houston and Parsons 2009; Koenig 2010, pers. comm.) have been independently validated according to procedures described in the RI/FS Work Plan. Specifically, the data for PCB congeners in tissue and sediment collected by TCEQ in 2008 and 2009 have been reclassified as Category 1 data following independent validation. These include tissue and sediment data from a single sample location (Station 11193) within the preliminary Site boundary and tissue data from several background locations (discussed below). As a result, these data can be used in the BHHRA. A report documenting the independent validation of these data is provided as Appendix A.

As a result of these considerations, the baseline dataset for the Site consists of:

- Sediment, tissue, and soil data collected for the RI/FS, including soil from the south impoundment planned for collection in February 2012[2]
- Sediment and water data collected by URS (2010) for the TCEQ in 2009.
- PCB congener data for fish tissue and sediments resulting from sampling conducted by TCEQ in 2008 and 2009.

[2] Planned sampling is documented in draft Addendum 3 to the Soil SAP for additional soil sampling south of I-10 (Integral 2011c)

At the request of USEPA (Miller 2011, pers. comm.), Category 2 tissue data available from 2005 and prior are included in Appendix B. These data will not be used to derive EPCs for the BHHRA because they are outdated and are of unknown quality.

3.2.1.2 Background Data

Comparison of Site-related risks to background risks will not necessarily be conducted for all exposure scenarios, environmental media, or $COPC_{HS}$. Rather, the comparison will be completed only for those scenarios and pathways that result in unacceptable Site risks and for which relevant background data are available. It is expected that ingestion of fish and/or shellfish by fishers will be an exposure pathway resulting in unacceptable risks at the Site. The potential for fish and crabs to move around the bay and be influenced by sources that are unrelated to the Site means that chemical concentrations found in edible tissues may be obtained from a combination of Site- and non-Site-related sources. Analysis of background information allows for consideration of other sources of risks at the Site, which is relevant to both risk assessment and evaluation of remedial alternatives. This context ensures that any remedial actions that may be taken at the site to reduce risk will actually result in reduction of exposure and risk originating from Site-related sources and is therefore relevant to risk management at the Site. Background data used for this purpose should also be representative of environmental media that people may actually contact, and provide a reasonable temporal match to the Site data. Background datasets for the BHHRA include:

- Sediment, tissue, and soil data collected for the RI/FS in background areas
- Tissue data collected by TCEQ as part of the TMDL program from stations downstream of the Site and in proximity to the Fred Hartman Bridge that have been reclassified as Category 1 data following independent data validation (Appendix A).

3.2.2 *Data Types*

The data types to be used to characterize each medium are discussed briefly below.

3.2.2.1 Sediment

Fishers and recreational visitors have potential for exposure to surface sediment in accessible shoreline areas of the Site. There is a limit, however, to the water depth into which these individuals will wade during these activities. To determine the boundary of the sediment that may result in direct contact exposures, Site bathymetry contours were mapped. The 2-foot depth contour (i.e., sediment covered by 2 feet of water or less) was considered the outer boundary of sediments that people using the Site may contact directly.[3] All shoreline and near-shore sediment data covered by 2 feet of water or less will be used to calculate EPCs for sediment for the fishing and recreational scenarios. As outlined in the Sediment SAP (Integral and Anchor QEA 2010) sediment samples collected from the 0- to 6-inch depth increment will be used to evaluate exposure to humans.

3.2.2.2 Tissue

Fishers may catch and consume finfish and/or shellfish from within the Site perimeter. The available tissue data include hardhead catfish fillet (skin removed), edible crab tissues, and edible clam tissues, which were collected to evaluate potential human exposures (Integral 2010a). A small amount of hardhead catfish (skin removed), data from TCEQ's TMDL program investigations also meet the data quality and temporal criteria for consideration in the quantitative BHHRA (Appendix A). Hardhead catfish fillet data will be used to estimate exposures through ingestion of finfish. Edible crab and clam tissues will be used to estimate exposures to shellfish.

There is uncertainty regarding the representativeness of available fish tissue data for characterizing actual exposures via ingestion that could potentially occur at the Site. This is because there is no Site-specific information regarding the extent to which various fish and shellfish types are collected from the Site and consumed, and only data for hardhead catfish, blue crab, and clams are available in the baseline dataset.

The use of hardhead catfish to represent all human exposure to finfish results in a conservative upper-end exposure for fishers consuming finfish from the Site. This is because

[3] The tidal condition at which the 0 foot contour was established is not known. This results in some uncertainty in the determination of sediment locations that are representative of human exposure.

hardhead catfish are benthic fish, which typically have higher concentrations of dioxins and furans than fish living and feeding in the water column within the same waterbody (e.g., USEPA 2009c). In addition, TCEQ's TMDL data for dioxins and furans in tissue indicate that other recreationally caught species generally have lower concentrations of dioxins and furans (as TEQ_{DF}) than hardhead catfish (Appendix B).

Uncertainties associated with the representativeness of tissue data designated for the BHHRA will be explored in the uncertainty evaluation completed as part of the BHHRA. Available information on species preferences described in the RI/FS Work Plan (i.e., Beauchamp 2010, pers. comm.) and from a study completed in Lavaca Bay (Alcoa 1998), and the impact of differing assumptions about the consumption of other species on risk estimates will be presented as part of this evaluation.

3.2.2.3 Soils

Fishers and recreational visitors have potential for exposure to soils in the area north of I-10, while trespassers and workers may be exposed to soils in the south impoundment area. Individuals who use the Site are anticipated to participate in activities that would potentially bring them into contact with surface soils. Site workers may additionally have contact with shallow subsurface soils during outdoor maintenance activities.

Under the soil investigations completed for the remedial investigation, soil from a variety of depth increments has been collected for each area and analyzed for $COPC_{HS}$ (Integral and Anchor QEA 2011). At locations north of I-10, these include:

- Co-located surface and shallow subsurface soils from 0 to 6 and 6 to 12 inches
- Surface soils from 0 to 8 and 0 to 12 inches
- Deep subsurface soils from 12 to 24 inches
- Soil cores from 48 to 60 inches.

At locations south of I-10, available soil samples include:

- Co-located surface and shallow subsurface soils from 0 to 6 and 6 to 12 inches
- Deep subsurface soils from 12 to 24 inches
- Soil cores in 2-foot intervals which include samples from the surface at 0 to

24 inches.

Additional co-located surface and shallow subsurface samples, and deeper soil cores within the south impoundment area were collected in April, 2012 (Integral 2011c).

Among these soil data, those for soils representing the surface condition (i.e., those collected from surface increments of 0 to 6, 0 to 8, 0 to 12, and 0 to 24 inches) will be used to evaluate exposure for fishers, recreational visitors, and trespassers. For Site workers in the south impoundment area data from these increments, as well as from the shallow subsurface increment of 6 to 12 inches will be used. For locations at which data for both 0- to 6- and 6- to 12-inch soils are available, depth-weighted average concentrations will be calculated for each sample location to represent the 0- to 12-inch interval, and will be used in the EPC calculation. The equation for calculating depth-weighted concentrations is provided below in Section 3.5.1.

3.3 Data Treatment

Data treatment rules outlined in the Project Data Management Plan (Appendix A of the RI/FS Work Plan) will be followed. The data plan includes rules for handling field duplicates, field splits, and laboratory replicate pairs.

Following USEPA (1989) guidance, for any $COPC_H$ detected at least once in a given medium, nondetected results that exceed the highest detected concentration will be excluded prior to calculation of EPCs. All other nondetected results that are within the range of detected concentrations will be retained and addressed as described below.

The RI/FS Work Plan for the Site further specifies the manner in which nondetected data will be treated. It specifies that two approaches will be used for handling nondetected results in the calculation of toxicity equivalent concentrations for dioxin-like PCB congeners (TEQ_P) and for dioxins and furans (TEQ_{DF}). Under the first approach nondetected results will be assumed to be equal to one-half of the estimated detection limit for each congener prior to multiplication of the appropriate toxicity equivalency factor (TEF) (see Table 4). Under the second approach, nondetected results will be assigned a value of zero, and incorporated into the TEQ. The results of both approaches will be presented in the risk assessment.

For calculation of concentrations of $COPC_{HS}$ other than dioxins and furans and dioxin-like PCBs, consistent with USEPA's QA/G-9 guidance (USEPA 2000b), nondetected results will be addressed considering the size of the dataset and the detection frequency. The following rules for handling nondetected values will be employed:

- For datasets with 10 or more samples (N ≥ 10) and a detection frequency of 50 percent or more (≥ 50 percent), nondetected values will be substituted with one-half the detection limit.
- For datasets in which N ≥ 10 and the detection frequency is between 20 and 50 percent[4], robust regression on order statistics (ROS) (Helsel 2005) will be used to generate values for nondetected values.
- For datasets with N < 10, regardless of the detection frequency, or with a detection frequency of less than 20 percent, regardless of sample size, nondetected values will be treated as one-half the detection limit. In these instances, nondetected values will not be estimated using ROS because the pool from which information about the data distribution can be drawn is insufficient for robust substitution methods.

Consistent with comments received from USEPA on the Tissue SAP (Integral 2010a, Appendix C), total PCBs in tissue will be calculated as the sum of 43 PCB congeners specified. The 43 specific congeners to be included are shown in Table 5. In cases in which additional PCB congeners co-elute with the 43 specified, these congeners will also be included in the sum for total PCBs. For the remedial investigation tissue and TMDL tissue datasets, these additional congeners to be included in the total PCB calculation are as follows: PCB-20, -30, -47, -61, -65, -69, -76, -83, -86, -90, -97, -109, -113, -115, -125, -129, -135, -163, -166, and -193. Their inclusion results in a sum that is biased high compared to the sum of the 43 congeners requested. The impact of this uncertainty on the overall risk estimate will be considered in the uncertainty evaluation for the BHHRA.

[4] Some flexibility will be applied around these limits. In the case that the dataset follows a distribution that reasonably supports substitution methods, such methods may be applied.

Consistent with USEPA guidance (2010b) and the approaches taken by the Texas Department of State Health Service's (TDSHS) Seafood and Aquatic Life Group (SALG) (TDSHS 2008), 100 percent of mercury detected in tissue will be evaluated as methylmercury. For soil and sediment, it will be assumed that 100 percent of mercury detected is in an inorganic form. Consistent with the state of knowledge regarding the proportions of inorganic and organic arsenic in fish tissues (USEPA 2003; ATSDR 2007) and approaches taken by TDSHS's SALG (TDSHS 2008), 10 percent of arsenic detected in tissue will be assumed to be inorganic arsenic. The remaining 90 percent will be assumed to be in an organic form. One hundred percent of the arsenic measured in soils and sediments will be assumed to be inorganic arsenic.

3.4 Exposure Units

According to USEPA Guidance (2002b), an exposure unit is an area throughout which a particular receptor moves and encounters an environmental medium for the duration of the exposure. Exposure units are thus intended to have a conceptual basis in the physical environment corresponding to an area within which receptor groups may come into contact with COPCs, and provide a physical frame of reference for describing risk. In this way, identification of exposure units facilitates risk management and future land use decision-making because the risk evaluation, which addresses each exposure unit, is then tied to a specific geographical area within which COPCs occur (USEPA 2002b; Anchor QEA and Integral 2010).

Selection of exposure units should also consider the statistical characteristics of the datasets (USEPA 2002b). Where concentrations of COPCs in environmental media vary within the site boundaries, exposure units are selected to allow the risk assessment to distinguish between areas on the Site with higher levels of risk and/or hazard to people from those areas with lower exposure and risk. Such a distinction also facilitates risk management decisions by indicating which areas are associated with the highest risk, and therefore which areas should be prioritized in remediation planning.

Statistical analyses are used to determine when different areas of the Site have significantly different COPC concentrations for a given medium. When the concentrations of any given COPC in different areas are not statistically different from each other, data for that COPC in that environmental medium can be pooled, which increases the statistical power of the resulting EPC. When data are pooled, the resulting statistic (e.g., 95UCL) represents the EPC for each of the physical areas of the site that is included in the pooled data.

This section describes the process for identification of exposure units for the following exposure media:

- Sediments from within the 1966 impoundment perimeter north of I-10 and aquatic environments of the Site
- Edible crab, catfish fillet, and clam tissue
- Soils for the area north of I-10
- Soils for the south impoundment area.

The data evaluations were conducted as described in the DQOs of the Tissue SAP (Integral 2010a). Exposure units representing both pre-TCRA and post-TCRA conditions are described. The specific samples to be used to calculate EPCs for each exposure unit are described in Table 6.

3.4.1 *Exposure Units for Sediments*

The determination of exposure units for sediments for the BHHRA follows the DQOs established in the Sediment SAP. Because the TCRA prevents contact with some sediments from on the Site, pre- and post-TCRA exposure units are relevant for sediments and are discussed below.

3.4.1.1 Pre-TCRA

As described in the COPC Technical Memorandum (Integral 2011a), sediment samples from five shoreline beach areas were collected to be used in characterization of human exposures. Following methodologies outlined in the Sediment SAP to evaluate the statistical similarities of $COPC_H$ concentrations in these areas, these areas were grouped into four separate exposure units. As described in the COPC technical memorandum, these are Beach Area

A—the shoreline to the west of the shipping berth on the property west of the impoundments; Beach Area B/C—the eastern shoreline of the sand separation area and the shoreline between the sand separation and west side of the impoundments; Beach Area D—the shoreline on the east side of the channel under the I-10 Bridge, and downstream; and Beach Area E—the shoreline of the river channel at the southeast corner of the waste impoundments. The sample locations associated with each of these four units are described in the COPC Technical Memorandum (Integral 2011a). In addition to the sediment sample locations described in that analysis, which were those proposed specifically to evaluate human exposures, 10 additional sample locations in the area of the impoundment (i.e., Beach Area E) were determined to be appropriate for evaluating human exposures in this area. These samples will be included within the Beach Area E exposure unit. In total, four sediment exposure units are defined.

The exposure units defined for evaluating pre-TCRA exposure conditions are shown in Figure 7. The environmental data for the exposure units are described in Table 6.

3.4.1.2 Post-TCRA

Fencing installed as part of the TCRA and by CWA limits land access to the shoreline surrounding the former northern impoundment, the area directly west of that impoundment, and on the east side of the channel beneath the I-10 Bridge. For the BHHRA, it will be assumed that fishers will not access these shorelines via boat, and therefore access to these areas will be completely restricted. In addition, the TCRA cap itself eliminates the potential for direct contact with materials within the original 1966 impoundment perimeter north of I-10. Therefore, under post-TCRA conditions, only the sediments in Beach Area A will be considered.

The exposure units defined for evaluating post-TCRA exposure conditions are shown in Figure 8. The perimeters of the fencing constructed as part of the TCRA and by CWA are also shown. Available environmental data for the areas are described in Table 6.

3.4.2 *Exposure Units for Tissue*

Hardhead catfish fillet, edible clam tissue, and edible crab tissue were collected from three fish collection areas (FCAs) as part of the remedial investigation (Integral 2010a; Integral and Anchor QEA 2012). Two FCAs are located north of I-10 and one south of I-10 (Figure 9). As described in Section 3.2 above, a few of the finfish samples collected on the Site in TCEQ's PCB TMDL study meet the data quality and temporal criteria for inclusion in the quantitative risk assessment (Appendix A) and will also be included in the dataset.

No tissue data exist that are representative of the post-TCRA condition at the Site. Therefore, representative tissue concentrations will be modeled using statistical relationships between Site sediment and tissue established in the Technical Memorandum on Bioaccumulation Modeling (Integral 2011d), or related methods. The sediment concentration used in such a modeling effort will be the post-TCRA surface-weighted average concentration (SWAC) in the sediment, calculated using data from within the tissue exposure unit.

3.4.2.1 Pre-TCRA

The analysis completed to identify exposure units for tissues for the BHHRA is presented below. The analysis described below follows the DQOs established in Section 1.8.3 of the Tissue SAP (Integral 2010a) and uses the hardhead catfish fillet, blue crab, and clam tissue data described above in Section 3.2.

3.4.2.1.1 Methods

Following the approach outlined in the Tissue SAP DQOs, analyses were carried out to determine whether, for each tissue type, data from the different FCAs could be pooled to represent a single exposure condition. Tissue chemistry data for datasets that are not significantly different were pooled. Nonparametric statistical tests were used because of the small sample sizes for the individual datasets and areas being compared (i.e., a maximum of 10 composite tissue samples per group). The following analyses were completed sequentially.

To determine whether historical data from the TMDL program for PCBs could be pooled with PCB data collected as part of the remedial investigation both non-statistical and statistical evaluations were undertaken. First, the ranges of total PCBs (as the sum of the 43 relevant congeners of interest described in Section 3.3) in the two geographically related datasets were examined side by side. In the case that the ranges showed no overlap, the datasets are not considered to be of the same sample population. If they did show an overlap in concentrations, a nonparametric (Mann Whitney Wilcoxon [MWW] test) was run to test the null hypothesis of equivalence. Statistical significance was evaluated at $\alpha = 0.05$. Groups of samples of the same tissue type from different studies that were not significantly different were pooled.

To determine whether data from the three FCAs represent equivalent exposure conditions, nonparametric tests to evaluate the null hypothesis of equivalence for each $COPC_H$ in each edible tissue type were conducted. For each edible tissue type, and each pair-wise combination of FCAs, a Mann Whitney U test was used to compare each $COPC_H$ between FCAs. Statistical significance was evaluated at an overall α of 0.05; individual $COPC_H$s were evaluated at an adjusted *p*-value, using the Bonferroni correction for multiple comparisons (USEPA 2009b). For hardhead catfish and clam, in which nine $COPC_H$s were detected,[5] an adjusted *p*-value of 0.0056 was employed. For blue crab, in which eight $COPC_H$s were detected,[6] an adjusted *p*-value of 0.0063 was employed. If differences for any $COPC_H$ in pair-wise FCA comparisons were statistically significant, the FCAs are considered different and the data were not pooled. FCAs that were not significantly different were combined into a single exposure unit for all $COPC_H$s. For cases where non-transitivity[7] arose from the results, and alternative pooling approaches could be used, additional analyses were carried out to determine whether either of those approaches were preferred.

Lastly, the appropriateness of pooling data for different tissue types was considered. The equivalence of the pooled FCAs for each tissue type (as a result of the analyses above) and the manner in which representative concentrations of $COPC_H$s in various types of tissue will be combined with other exposure parameters to estimate intake in the BHHRA were considered.

[5] BEHP was not detected in hardhead catfish fillet or clam tissue.
[6] BEHP and nickel were not detected in edible blue crab tissue.
[7] If two areas are each equivalent to a third area but they are not equivalent to each other, then the results of the two-sample tests are not transitive.

3.4.2.1.2 Results

The stepwise analysis outlined above supported the pooling of hardhead catfish fillet data for PCBs from the TCEQ TMDL program with hardhead catfish fillet data collected from FCA 1 for the remedial investigation. It additionally supported pooling hardhead catfish fillet data for all COPC$_{HS}$ in FCA 2 and 3, blue crab data for all COPC$_{HS}$ in FCA 2 and 3, and clam data for all COPC$_{HS}$ in FCA 1 and FCA 3. Results for each of the statistical comparisons are detailed in Appendix C and discussed briefly below.

Pooling Data from the TMDL PCB and Remedial Investigation Studies

Three hardhead catfish fillet samples collected as part of TCEQ's TMDL program and 10 hardhead catfish fillet samples collected for the remedial investigation were collected from within FCA 1. The maximum concentration for the sum of the 43 PCB congeners of interest for the TMDL PCB samples was slightly higher than the maximum concentration from the catfish collected from FCA 1 as part of the remedial investigation, but the majority of each distribution overlapped the other (TMDL total PCB: 48.9 to 156 µg/kg (N=3); RI, FCA1: 18.2 to 132 µg/kg (N=10)). Given the considerable overlap in the ranges, the hardhead catfish fillet data from the two studies were tested for equivalence. The results of the MWW test indicated that total PCBs as the sum of the 43 PCB congeners of interest in the two sample populations were not significantly different ($p > 0.05$). Therefore, hardhead catfish fillet samples from the two datasets can be pooled, and calculation of EPCs for total PCBs in hardhead catfish fillet from FCA 1 will be calculated from the pooled data.

Pooling Data from FCAs for Individual Tissue Types

Nonparametric tests were run for each pair-wise combination of FCAs for each COPC$_H$. The analyses were run separately for each tissue type: hardhead catfish fillet, crab, and clam.

Hardhead Catfish Fillet

For hardhead catfish fillet, the comparison of FCAs 1 and 3 did not support the null hypothesis that samples from these two FCAs were taken from a common distribution. Results of the MWW test indicated that mercury was the only COPC$_H$ in hardhead catfish fillet that differed between FCA 1 and FCA 3 ($p < 0.0056$). No COPC$_{HS}$ in hardhead catfish fillet differed between FCA 1 and FCA 2, or between FCA 2 and FCA 3. Under the conditions of non-transitivity (i.e., FCA 2 is not dissimilar to FCA 1 or FCA 3, but FCA 1 is not similar to FCA 3), additional analyses were carried out to determine whether COPC$_H$s in hardhead catfish fillet from FCA 2 are more similar to COPC$_H$s in tissue from FCA 1 or FCA 3 in order to determine the preferred pooling (i.e., pooling hardhead catfish fillet data from FCA 2 and FCA 1, or from FCA 2 and FCA 3).

To determine the preferred pooling of FCAs, the similarity between each pair of FCAs 1, 2, and 3 was examined using Euclidean distance as a similarity metric, calculated using data for all COPC$_H$s. The Euclidean distance is the distance between two points and is measured by the Pythagorean formula as the square root of the sum of squares of the X-distance and Y-distance between their coordinates. Because there are nine COPC$_H$s, each point is represented by a point with nine coordinates rather than just two. The formula for Euclidean distance is applicable to such multivariate datasets (Kachigan 1982; Legendre and Legendre 1998). The Euclidean distance is a measure of the similarity in the make-up of concentrations of all COPC$_H$s between two samples: a smaller Euclidean distance indicates a greater similarity.

Because concentrations of different COPC$_H$s have different magnitudes, to allow each COPC$_H$ to contribute equally to the overall measure of similarity, the concentrations of individual COPC$_H$s need to be standardized before distance calculations are made. To standardize and scale COPC$_H$ concentrations prior to the distance calculation, first, the entire dataset (for all FCAs) was centered so that the mean for each COPC$_H$ was set at zero. Next the entire dataset (for all FCAs) was scaled so that the standard deviation for each COPC$_H$ was set to 1. Euclidean distances were then determined by calculating the distances between all pairs of hardhead catfish fillet samples in each pair of FCAs.

The findings of the analysis indicate that hardhead catfish fillet from FCAs 2 and 3 are more similar than data from FCAs 1 and 2, and therefore FCAs 2 and 3 should be pooled. A plot of the Euclidean distance for all samples between each pair of FCAs is provided in Figure C-1.

Edible Blue Crab

For edible blue crab, the statistical comparisons supported the hypothesis that data from FCAs 2 and 3 were taken from the same distribution. Data from FCA 1 do not appear to be taken from the same distribution. Results of the MWW tests indicated that cadmium and TEQ_{DF} in edible crab tissue differed between FCA 1 and FCA 3 ($p < 0.0063$) and that mercury and PCBs in edible crab tissue differed between FCA 1 and FCA 2, and between FCA 1 and FCA 3 ($p < 0.0063$). There was no difference between FCA 2 and FCA 3 for any $COPC_H$, and the results therefore support pooling samples from FCA 2 and FCA 3.

Edible Clam Tissue

For edible clam tissue, the statistical comparisons of FCAs 1 and 2, and FCAs 2 and 3 did not support the null hypothesis that tissue samples were taken from a common distribution. Results of the MWW tests indicated that nickel in edible clam tissue differed between FCA 1 and FCA 2 ($p < 0.0056$) and that zinc differed between FCA 2 and FCA 3 ($p < 0.0056$) There was no difference between FCA 1 and FCA 3 for any $COPC_H$, and the results therefore support pooling samples from FCA 1 and FCA 3.

Pooling Data for Tissue Types

The appropriateness of pooling data for hardhead catfish fillet and edible blue crab, for which identical determinations on the FCAs that are appropriate to pool were established, was considered. As discussed further in Section 4, exposures to finfish and shellfish will be quantified separately using different ingestion rates, and individuals assumed to ingest finfish will not necessarily be assumed to ingest shellfish and vice versa. Therefore, it was determined that the hardhead catfish fillet and edible clam tissues should not be considered further for pooling.

3.4.2.1.3 Summary

The analysis resulted in the following exposure units for each tissue type to be used in the pre-TCRA exposure scenarios:

- Hardhead catfish fillet—FCA 2 and FCA 3 will be pooled (“FCA 2/3”). This pooled FCA and FCA 1 will be considered two individual exposure units with unique EPCs for each $COPC_H$.

- Edible crab—FCA 2 and FCA 3 will be pooled ("FCA 2/3"). This pooled FCA and FCA 1 will be considered two individual exposure units with unique EPCs for each $COPC_H$.
- Edible clam—FCA 1and FCA 3 will be pooled ("FCA 1/3"). This pooled FCA and FCA 2 will be considered two individual exposure units with unique EPCs for each $COPC_H$.

The exposure units defined for evaluating pre-TCRA exposure conditions are shown in Figure 9. The environmental data available for the areas are described in Table 6.

3.4.2.2 *Post-TCRA*

No tissue data that are representative of post-TCRA conditions are available. As a result, it will be necessary to estimate concentrations in relevant tissue types for those $COPC_H$s that show unacceptable risks under baseline conditions. The Technical Memorandum on Bioaccumulation Modeling (Integral 2010d) presents a suite of Site- and region-specific statistical models that can be used to predict tissue concentrations of some dioxin and furan congeners from their respective sediment concentrations, including the most potent congeners. These empirical statistical relationships provide a means to estimate tissue concentrations for a specific analyte, taking as inputs the concentrations of the same analyte in sediment, as well as ancillary information, such as total organic carbon (TOC), fines, and season.

Post-TCRA tissue concentrations will be estimated using these statistical models applied to the post-TCRA sediment data for the dioxin and furan congeners for which a statistical relationship has been established. Model inputs will be the post-TCRA sediment EPCs for each relevant exposure area, as well as associated matrix physical properties (e.g., TOC, grain size). Sediment concentrations that will be used for calculating the post-TCRA EPCs for tissue will be represented as SWACs of the exposure areas described in Section 3.5.2.

3.4.3 *Exposure Units for Soils*

The determination of exposure units for soils for the BHHRA is based on an understanding of which areas are accessible for each CSM area under pre-and post-TCRA conditions. Prior to the TCRA, the area north of I-10 could be freely accessed by fishers, recreational users, and trespassers. Fencing installed as part of the TCRA and by CWA has made much of the area inaccessible. Areas south of I-10 have historically and are currently designated for industrial activities, and fencing surrounding the area has made this area largely inaccessible to individuals. There is a potential that trespassers could access the area to a limited degree, and workers can access the area.

3.4.3.1 North of I-10

The TCRA changed the areas of the Site with which individuals may come into contact and, therefore, both pre- and post-TCRA exposure units for soil must be defined. Each is discussed below.

3.4.3.1.1 Pre-TCRA

Soil sampling locations in the area north of I-10 are fairly evenly distributed. Moreover, individuals may come into contact with all areas, rather than be isolated to a confined portion of the Site. Therefore, the soil data will be considered collectively as a single exposure unit representative of pre-TCRA conditions. All of the samples collected in the Texas Department of Transportation right-of-way are in this group.

The exposure unit defined for evaluating pre-TCRA exposure conditions is shown in Figure 10. The environmental data for the exposure unit are described in Table 6.

3.4.3.1.2 Post-TCRA

Fencing constructed as part of the TCRA limits access to some areas of the Site north of I-10. Therefore, a more limited set of soil samples will be considered to be the exposure unit representative of post-TCRA soils. Specifically, only six soil samples fall within the area of the Site that remains accessible to individuals following the TCRA; these are SJTS028, -29, -30, -and -31, and TxDOT001 and -007. These six samples represent the post-TCRA exposure unit for soils north of I-10. The uncertainty associated with the relatively small sample size for this area will be evaluated in the uncertainty evaluation completed as part of the BHHRA.

The exposure unit defined for evaluating post-TCRA soil exposure conditions is shown in Figure 11. The environmental data for the exposure unit are described in Table 6.

3.4.3.2 South Impoundment Area

The TCRA implemented in the northern portion of the Site and the fencing installed by CWA had no impact on the soils in the south impoundment area. Chemistry data available for soils in this area, combined with stations designated for sampling in February 2012, are fairly evenly distributed throughout the area that individuals are anticipated to potentially contact. No information is available to suggest that individuals who might potentially trespass or work in the south impoundment area would be confined to any specific subareas. Therefore, the soil data, including results from both Phase I and Phase II sampling events, will be considered collectively as a single exposure unit.

The exposure unit defined for evaluating exposure conditions in the south impoundment area are shown in Figure 12. The environmental data for this exposure unit are described in Table 6.

3.5 Exposure Point Concentrations

This section outlines the methods that will be used to calculate EPCs for the BHHRA. The approach that will be used to calculate EPCs using available data (i.e., pre- and post-TCRA soil and sediment, and pre-TCRA tissue) is outlined in Section 3.5.1. The method for modeling post-TCRA dioxin and furan EPCs for tissue is discussed in Section 3.5.2.

3.5.1 *Using Medium Specific Data*

EPCs will be calculated for each $COPC_H$ in each exposure unit using the rules for handling nondetected values described in Section 3.4. The detection frequency for each of the $COPC_H$ datasets for each of the established exposure units is presented in Appendix D.

Where data are available for more than one relevant depth interval at a single location, depth-weighted concentrations will be calculated. These depth-weighted concentrations will be calculated prior to the calculation of the EPC using the following equation:

$$C_{weighted} = \frac{(C_1 \times d_1) + (C_2 \times d_2) + \ldots\ldots + (C_n \times d_n)}{d_1 + d_2 + \ldots + d_n} \quad \text{(eq. 3-1)}$$

Where:

$C_{weighted}$	=	depth-weighted concentration
$C_{1,2,\ldots n}$	=	concentration for depth increment analyzed.
$d_{1,2,\ldots,n}$	=	fraction of the total depth represented by the depth increment.

EPCs will be calculated using the software R for Windows version 2.9.0 (R Development Core Team 2008). CT and RM EPCs will be generated.[8] The statistics selected will be appropriate to the data as follows:

- For normal data distributions, the arithmetic mean will be chosen as the CT EPC. The lesser of the 95UCL based on a Gaussian data distribution and the maximum value will be selected for the RM EPC.
- For lognormal distributions, the geometric mean will be chosen as the CT EPC. The lesser of the 95UCL, based on a lognormal data distribution, and the maximum value for the dataset will be selected for the RM EPC.
- For other or unknown data distributions (i.e., those distributions that are not normal and cannot be transformed to a log-normal distribution), the arithmetic mean will be chosen as the CT EPC. The lesser of the 95UCL, based on an unknown distribution, and the maximum value for the dataset will be selected for the RM EPC.

The distribution of each dataset and the recommended EPCs and their bases will be included in the BHHRA.

3.5.2 *Post-TCRA Tissue*

For those dioxin and furan congeners for which significant statistical relationships between sediment and tissue are available, the best-fit regression models established (Integral 2011d) will be used to predict post-TCRA concentrations of those congeners in tissues. SWACs for

[8] A discussion of the purposes of CTE and RME estimates in risk assessment is provided in Section 4 in the broader context of defining the full range of assumptions used to estimate exposure.

surface sediments for each exposure unit will be used as inputs for the models. The modeled tissue concentrations for individual congeners will be used along with congener-specific TEF,[9] to calculate post-TCRA TEQ_{DF} concentrations. To explore the impact of uncertainties associated with the regression models, the range of error in the tissue concentrations that are predicted by each regression at a given sediment concentration will be considered in the exposure estimate, and a range of EPCs for post-TCRA tissue will be presented.

While statistically significant regression models for all 17 dioxin-like congeners are not available for each of the tissue types, there are models for the congeners with the highest concentrations in tissue, and the highest toxicity relative to 2,3,7,8-TCDD (see Appendix E, Table E-1 for an analysis of the mixture of congeners in tissue). Nevertheless, all 17 dioxin like congeners will not be included in the estimated post-TCRA TEQ_{DF} for any of the tissue types, and resulting modeled TEQ_{DF} concentrations will therefore be biased low. The uncertainty associated with this approach will be addressed by using regression statistics calculated on the basis of TEQ_{DF} for both sediment and tissue, as provided in the final PSCR at the request of USEPA.

[9] TEFs are shown in Table 4. Methods for calculating TEQ_{DF} are described in Section 3.3 and the project Data Management Plan.

4 EXPOSURE EQUATIONS AND PARAMETERS

To quantify exposure, human intake levels resulting from contact with COPCs are estimated using exposure algorithms. The algorithms quantify each type of exposure as an intake, defined as the mass of a chemical contacted per unit body weight per unit time. As is customary in the field of health risk assessment, intake will be expressed in one of two forms, depending on the type of risk that is being assessed. Average daily dose (ADD) and lifetime average daily dose (LADD) will be used as measures of intake for characterizing noncarcinogenic[10] and carcinogenic effects, respectively. The difference between these two dose metrics is the time period over which the exposure is averaged, with the averaging time equivalent to the exposure duration for the ADD and the averaging time equivalent to a lifetime for the LADD.

USEPA (1993) guidance for Superfund recommends that two types of exposure estimates be calculated. The reasonable maximum exposure (RME) is defined as the highest exposure that could reasonably be expected to occur for a given exposure pathway and scenario at a site. The RME is intended to account for uncertainty in the contaminant concentration, and for variability and uncertainty in exposure parameters. USEPA also recommends that the central tendency estimate (CTE), or average estimate of exposure, be presented in the risk assessment. Both RME and CTE estimates will be calculated for the BHHRA.

The variables in the exposure algorithms are called exposure factors. The value selected for each factor represents a specific assumption or set of assumptions, and depends on the receptor population being evaluated. Some of these are site-specific and can be measured for the Site, and others are assumptions taken from literature or USEPA sources. Consistent with the RI/FS Work Plan (Section 6.3.3.3) (Anchor QEA and Integral 2010), several regulatory agency and literature sources have been considered when deriving parameter values, including the following:

[10] Most carcinogenic compounds are evaluated using a LADD. However, as described in the Toxicological and Epidemiological Studies Memorandum (Integral 2012), the carcinogenicity of some compounds depends on whether the level of exposure reaches a threshold dose. To characterize risk for these carcinogens, the exposure metric will be presented as an ADD.

- Risk Assessment Guidance for Superfund (RAGS) Volume I Part A (USEPA 1989)
- RAGS Volume I Part B—Development of Risk-Based Preliminary Remediation Goals (USEPA 1991a)
- RAGS Volume I Part C—Risk Evaluation of Remedial Alternatives (USEPA 1991b)
- Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors (USEPA 1991c)
- Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure (USEPA 1993)
- Soil Screening Guidance: User's Guide (USEPA 1996)
- Exposure Factors Handbook (USEPA 2011b)[11]
- Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA 2002c)
- RAGS Volume I Part E—Supplemental Guidance for Dermal Risk Assessment (USEPA 2004)
- Texas Administrative Code sections containing exposure equations and parameters (TAC 350.74-75)

In addition, regionally relevant information on fish and shellfish consumption was considered (Alcoa 1998).

The remainder of Section 4 presents the specific equations, parameters, and assumptions that will be used to quantify exposure in the BHHRA. First, the exposure equations and a general discussion of the parameters used within them are presented. Next, the way in which exposures will be characterized for each receptor group is presented. This presentation includes a discussion of the exposure scenarios that will be characterized including the manner in which exposures from individual pathways will be summed, and the parameters and assumptions that will be used for each individual pathway. Finally, chemical-specific parameters are discussed.

[11] The final 2011 Exposure Factors Handbook was released in September 2011, superseding the 2007 Exposure Factors Handbook and the 2008 Child-Specific Exposure Factors Handbook.

The specific scenarios for which intake will be quantitatively evaluated are presented in Table 7. The full sets of exposure factor assumptions to be used in the BHHRA along with the pathway-specific equations for calculating intake are presented in Tables 8 through 12. Tables 13 and 14 present summaries of the assumptions to be applied in the BHHRA for assessing exposure pathways in the area north of I-10 and aquatic environment, and the south impoundment area, respectively. Table 15 presents the chemical-specific parameters to be used in the BHHRA.

4.1 Introduction to Exposure Equations and Parameters

The specific equation and parameters used to estimate intake varies, depending on the exposure route being evaluated. Three types of exposures will be evaluated in the BHHRA: 1) ingestion of sediment and/or soil, 2) dermal absorption of sediment and/or soil, and 3) ingestion of fish and/or shellfish. The equations that will be used to calculate these exposures are presented below. A general explanation of the exposure parameters that are included in the equations follows.

Equation 4-1. Intake via Ingestion of Soil and/or Sediment

Relevant Receptor Groups: fishers, recreational visitors, trespassers, workers

$$I_{soil-sed} = \frac{\left[\left(C_{soil} \times IR_{soil} \times F_{soil}\right) + \left(C_{sed} \times IR_{sed} \times F_{sed}\right)\right] \times RBA_{soil-sed} \times FI_{soil-sed} \times EF_{soil-sed} \times ED \times CF_1}{BW \times AT} \quad \text{(eq. 4-1)}$$

Where:

$I_{soil-sed}$	=	intake, the mass of a chemical contacted in soil and sediment by the receptor per unit body weight per unit time (mg/kg-day)
C_{soil}	=	chemical concentration in soil contacted over the exposure period (i.e., EPC for soil) (mg/kg)
IR_{soil}	=	soil ingestion rate (mg/day)
F_{soil}	=	fraction of total ingestion that is soil (% as fraction)
C_{sed}	=	chemical concentration in sediment contacted over the exposure period (i.e., EPC for sediment) (mg/kg)
IR_{sed}	=	sediment ingestion rate (mg/day)
F_{sed}	=	fraction of total ingestion that is sediment (% as fraction)

RBA_{ss}	=	relative bioavailability adjustment for soil and sediment (% as fraction)
$FI_{soil\text{-}sed}$	=	fraction of total daily soil/sediment intake that is site-related (% as fraction)
$EF_{soil\text{-}sed}$	=	exposure frequency (days/year)
ED	=	exposure duration (years)
CF_1	=	conversion factor ($1x10^{-6}$ kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days)

Equations 4-2 and 4-3. Dermal Absorbed Dose via Contact with Soil and Sediment

Relevant Receptor Groups: fishers, recreational visitors, trespassers, workers

$$DAD_{soil-sed} = \frac{DA_{event} \times SA \times EF_{soil-sed} \times FI_{soil-sed} \times ED \times EV}{BW \times AT} \qquad \text{(eq. 4-2)}$$

Where:

$DAD_{soil\text{-}sed}$	=	dermal absorbed dose from soil and sediment (mg/kg-day)
DA_{event}	=	absorbed dose per event (mg/cm^2)
SA	=	skin surface area available for contact (cm^2)
EV	=	event frequency (day^{-1})

And,

$$DA_{event} = \left[\left(C_{soil} \times AF_{soil} \times F_{soil}\right) + \left(C_{sed} \times AF_{sed} \times F_{sed}\right)\right] \times ABS_d \times CF_1 \qquad \text{(eq. 4-3)}$$

Where:

AF_{soil}	=	adherence factor for soil (mg/cm^2)
AF_{sed}	=	adherence factor for sediment (mg/cm^2)
ABS_d	=	dermal absorption factor for soil/sediment (% as fraction)

Equation 4-4. Intake via Ingestion of Fish and Shellfish

Relevant Receptor Groups: fishers

$$I_{tissue} = \frac{C_{tissue} \times (1 - LOSS) \times IR_{tissue} \times RBA_{tissue} \times FI_{tissue} \times EF_{tissue} \times ED \times CF_2}{BW \times AT} \quad \text{(eq. 4-4)}^{12}$$

Where:

I_{tissue}	=	intake, the mass of a chemical contacted in fish or shellfish tissue by the receptor per unit body weight per unit time (mg/kg-day)
C_{tissue}	=	chemical concentration in fish or shellfish tissue contacted over the exposure period (i.e., EPC for fish or shellfish) (mg/kg)
LOSS	=	chemical reduction due to preparation and cooking (% as fraction)
IR_{tissue}	=	fish or shellfish ingestion rate (g/day)
RBA_{tissue}	=	relative bioavailability adjustment for tissue (% as fraction)
FI_{tissue}	=	fraction of total fish or shellfish intake that is site-related (% as fraction).
EF_{tissue}	=	exposure frequency for fish or shellfish consumption (days/year)
CF_2	=	conversion factor (1×10^{-3} kg/g)

A general description of the exposure parameters included in the preceding equations 4-1 through 4-4 is presented below. General parameters used in all equations are discussed first, followed by pathway-specific parameters. The specific values that will be used for each parameter for Site receptors are presented in Section 4.2.

Body Weight (BW)

USEPA (2004) recommends that mean age specific body weights be assumed for both CTE and RME scenarios. USEPA's 2011 Exposure Factors Handbook (USEPA 2011b) provides mean values for body weight by age, based on data collected from the 1999–2006, National Health and Nutrition Examination Survey (NHANES). Age-specific mean body weights from this source have been adopted for the BHHRA.

[12] The equation presented here uses the term tissue generically to present parameters for finfish and shellfish. Intake of finfish and shellfish will be estimated separately for the BHHRA.

Exposure Frequency (EF)

The exposure frequency is the average number of days per year that an individual is exposed at a site. While USEPA guidance recommends exposure frequencies for residential and worker populations (350 days/year and 225 to 250 days/ year for various types of workers, respectively) (USEPA 2002c), they do not provide recommendations for this parameter for recreational or trespasser scenarios. USEPA's default factors and best professional judgment were used to select exposure frequencies for the BHHRA.

Exposure Duration (ED)

The exposure duration is the number of years over which an exposure occurs. USEPA (2011b) provides standard default assumptions for residence time based on studies of occupational mobility. Thirty-three years and 12 years are recommended as RME and CTE estimates, respectively. USEPA (2002c) recommends an exposure duration of 25 years for commercial/industrial workers based on the Bureau of Labor Statistics 95th percentile value for job tenure for men in the manufacturing sector. These default values and best professional judgment were used to select exposure durations for the BHHRA.

Averaging Time (AT)

The averaging time selected depends on the toxic endpoint (cancer or noncancer) being assessed. For noncarcinogens, the averaging time equals the exposure duration (e.g., for an exposure duration of 6 years, the averaging time is 2,190 days). For carcinogens, the averaging time is equal to a lifetime (i.e., 78 years, or 28,470 days) (USEPA 1989, 2011b). This distinction relates to the manner in which toxicity criteria are generally developed for non-carcinogens and carcinogens. Generally, the toxicity of carcinogens is described using criteria that assume a linear dose response, where any incremental dose results in an increased risk of cancer (i.e., no threshold is assumed). However, in some cases, the toxicity of a carcinogen is described using a criterion that assumes a threshold dose of the substance is required in order for an adverse effect to be elicited. When the toxicity criterion for a carcinogen assumes a threshold dose, an averaging time equal to the exposure duration will be used.

Soil and Sediment Ingestion Rates (IR_{soil}, IR_{sed})

USEPA (2011b) provides recommendations for soil ingestion rates for a variety of age groups. USEPA guidance does not provide default ingestion rates for sediment, and there are no studies available in the peer-reviewed literature to provide the basis for an estimate. In the absence of data on specific ingestion rates for sediment, soil ingestion rates from USEPA will be applied to both soil and sediment media.

USEPA (2011b) recommends an ingestion rate of 20 mg/day for typical adults. Based on the assumption that workers may be involved in contact-intensive activities, USEPA (2002c) suggests a higher soil ingestion rate of 100 mg/day for outdoor workers. Young children may ingest larger amounts of soil daily because of greater hand-to-mouth activity. USEPA (2011b) recommends an ingestion rate of 50 mg/day as the central tendency rate for individuals ages 1 to <21 years. In addition, for children ages 3 to <6 years, USEPA recommends an upper-bound estimate of 200 mg/day.

Recommended central tendency rates, and when available, upper-bound estimates, were adopted for the BHHRA for CTE and RME estimates, respectively. Following recommendations from USEPA (2011b), weighted average rates were calculated in order to characterize ingestion rates for different age groups across a period of time that encompasses more than one age group.

Surface Area (SA)

The surface area factor describes the amount of exposed skin that may come into contact with soil or sediment. USEPA (2011b) provides recommended surface areas for individual body parts for a range of age groups based on data collected from the 1999–2006 NHANES. USEPA (2004) recommends adopting mean surface areas for both CTE and RME scenarios. Age specific surface areas for men and women combined from USEPA (2011b) were selected for the BHHRA.

Adherence Factor for Soil/Sediment

The adherence factor describes the mass of soil or sediment that adheres to the skin per unit of surface area. Adherence is influenced by the properties of the soil or sediment (e.g., moisture content), and also varies considerably across different parts of the body and with different activities (USEPA 2004).

USEPA (2004, 2011b) provides adherence factors for a variety of activities including those that describe residential, recreational, and occupational exposures. The majority of the data are available for the soil matrix; however, data are available from one study that measured adherence of sediment to skin in children.

Adherence factors were selected from data provided by USEPA to match the receptor of interest, its activity, and the soil/sediment matrix as closely as possible. Sediment data available for children were used for all ages given the lack of available data for other age groups.

Following USEPA recommendations, weighted adherence factors were calculated for each age group on the basis of relative surface areas of exposed body parts and body-part-specific adherence factors presented by USEPA. The same assumptions were selected for both CTE and RME scenarios.

Event Frequency

"Event frequency" refers to the number of times per day an event occurs on any exposure day. For dermal contact with both soil and sediment, the event frequency is assumed to be 1.

Fractions of Total Pathway Exposure to Soil and to Sediment (F_{soil}, $F_{sediment}$)

These factors apportion the direct contact individuals have at the Site between soil and sediment. The soil and sediment ingestion rates discussed above are developed as total daily intake rates. To assume that an individual is exposed to both soil and sediment, and use the default daily ingestion rates to evaluate both, would result in large overestimates of potential exposure. Instead, it is more appropriate to assume that this total daily intake will be from a combination of soils and sediments contacted during the day as appropriate for the scenario.

In addition, the adherence factors described above will differ between soil and sediment. To estimate exposure, it is therefore necessary to describe the portion of the dermal exposure pathway that will be attributable to soil and sediment. Professional judgment about likely scenario-specific activities was used to assign these fractions.

Fraction of Total Daily Intake from Soil/Sediment That Is Site-Related (FI $_{\text{soil-sediment}}$)

The intent of this fractional intake term is to provide a modifying factor to account for situations when the total daily intake rate (e.g., the fraction of sediment multiplied by the sediment ingestion rate and the fraction of soil multiplied by the soil ingestion rate) for an individual would not be derived exclusively from the Site. Assuming a fractional intake of 1.0 implies that all sediment and soil incidentally ingested and absorbed via dermal contact during a daily exposure originated from the Site. In instances where individuals spend only a few hours at the Site, and also participate in other activities away from the Site where they will be exposed to sediment or soil, a fractional intake of less than 1.0 will be more appropriate for estimating exposure. Information about the Site was considered when determining the value for this factor for each receptor.

Ingestion Rates for Fish and Shellfish

Ingestion rates of self-caught fish and shellfish tissue can vary dramatically depending upon location/region, type of fishing, and species of fish caught. USEPA has a developed a number of default consumption rates for fish and shellfish consumption based on national, regional, and site-related surveys. However, because of the variable nature of consumption patterns, USEPA (2011b) recommends using Site- or region-specific information when such data exist and are of good quality. Both default consumption rates and regional data on consumption were reviewed to select the most appropriate values for the BHHRA.

Fraction of Total Fish or Shellfish Intake That Is Site-Related

The fractional intake term represents the fraction of total fish and shellfish consumption that is specifically harvested from the Site. A fractional intake of 1.0 reflects an assumption that 100 percent of the fish and shellfish consumed is harvested at the Site. The fractional term will be dependent on a number of Site-specific parameters including the accessibility and size of the Site and the number of alternative fishing locations surrounding the Site. Information about the Site was considered when determining this factor.

Other Parameters

Chemical specific parameters shown in equations 4-1 through 4-4 including EPCs, relative bioavailability adjustment (RBA) factors, dermal absorption factors, and factors that account for chemical loss due to preparation and cooking are discussed elsewhere. Specifically, methods for calculating EPCs for sediments, tissue, and soils are presented in Section 3.5. The remaining chemical specific parameters are presented in Section 4.3.

4.2 Area-Specific Exposure Parameters and Assumptions

This section provides a detailed description of the way that exposure will be estimated in the BHHRA. It describes each receptor group, the scenarios for which exposure will be evaluated, and the exposure factors that will be used to calculate intake. The exposures to be evaluated in the area north of I-10 and aquatic environment and the south impoundment area are discussed in Sections 4.2.1 and 4.2.2, respectively.

4.2.1 *Area North of I-10 and Aquatic Environment*

This section details the specific exposures that will be characterized and the exposure assumptions that will be adopted in the BHHRA for the north impoundment area.

4.2.1.1 Receptor Groups and Exposure Scenarios

Two types of fishers are outlined as human receptors in the CSM for this area: a recreational fisher and a subsistence fisher. The recreational fisher is assumed to be an individual who periodically fishes on the Site. USEPA (2011b) defines subsistence fish consumers as those individuals who rely on sport-caught fish as a source of food and, as a result, eat more fish than the general population.[13] Recreational visitors have also been identified as a receptor group with potential exposures for this area. Recreational visitors may walk around, or spend time recreating throughout the Site.

Fishers and recreational visitors may come into contact with soils in the area north of I-10 and/or sediments throughout the areas of the Site in which the water is shallow enough to

[13] Because these individuals are a hypothetical subpopulation of the fishers who may use the Site and their definition is based on higher than typical consumption rates, no CTE evaluation will be conducted for the subsistence fisher scenario. Only an RME evaluation will be completed for this receptor group.

allow for wading. Given that the primary activity of the fisher occurs at the shoreline, it will be assumed that their exposures to soils will be inconsequential compared with their potential exposures to shoreline and near-shoreline sediment. It is assumed that recreational visitors may have contact with both near-shoreline sediment and soil. Potentially complete exposure pathways via these matrices include direct ingestion and dermal absorption.

Both groups of fishers may ingest fish and/or shellfish caught at the Site. Information regarding fishing activities and consumption patterns at the Site is not available. In the absence of specific information on diet, exposures will be estimated separately under three scenarios: one scenario will consider finfish ingestion only, a second will consider crab ingestion only, and a third will consider clam ingestion only. Focusing the risk assessment on single-tissue type exposures is conservative because it will identify and quantify exposure to the tissue type that results in the highest potential for exposure. In estimating cumulative exposure, exposure from direct contact pathways (ingestion and dermal absorption of soil and/or sediment) will be summed with that from each tissue ingestion scenario separately. The result will be three different cumulative intake estimates. The impact of this assumption will be evaluated in the uncertainty evaluation completed for the BHHRA. Exposure via a mixed diet (i.e., where the total diet coming from fish and shellfish is assumed to be composed of some proportion of finfish, crab, and clam) will be considered as part of this uncertainty evaluation.

The scenarios for which exposure will be evaluated in the BHHRA are described in Table 7. The scenarios reflect the complete pathways and the exposure units established in Section 3.4. They are:

- Fishers—direct contact (i.e., ingestion of and dermal absorption) with sediments at individual exposure units defined for sediments, summed with ingestion of tissue from geographically corresponding exposure units for tissue. Three tissue ingestion scenarios will be considered: 1) ingestion of finfish from the Site, 2) ingestion of edible crab from the Site, and 3) ingestion of edible clam from the Site. Exposures to younger children (ages 1 to < 7), older children (ages 7 to < 18), and adults will be considered.
- Recreational Visitors—direct contact (i.e., ingestion of and dermal contact) with sediments at individual exposure units defined for sediments, summed with direct

contact at the single exposure unit defined for soil. Exposures to younger children (ages 1 to < 7), older children (ages 7 to < 18), and adults will be considered.

These scenarios will conservatively assume that each fisher and recreational visitor spends all of his or her time at a single beach area (i.e., A, B/C, D, or E). For the fisher, it will be further assumed that all of the tissue that is consumed is harvested from the FCA that borders that beach area. Although it is anticipated that fishers and recreational visitors would likely visit more than a single beach area over the chronic exposure duration being evaluated, estimating exposures at each exposure unit separately allows for incremental exposures that potentially occur in statistically different units to be evaluated, providing a stronger basis for risk management decisions. The impact of this assumption will be discussed in the uncertainty analysis.

The entire Site is accessible under pre-TCRA conditions but fencing constructed as part of the TCRA and by CWA currently limits access to Beach Areas B/C, D, and E. These limitations to Site access will be captured in the post-TCRA exposure scenarios described.

4.2.1.2 Exposure Assumptions

Exposure assumptions for the recreational fisher, subsistence fisher, and recreational visitor are summarized in Tables 8, 9, and 10, respectively, and are discussed below.

4.2.1.2.1 Exposure Parameters Common to All Pathways

Given the lack of Site-specific information on fishing and recreational behaviors, exposure durations were conservatively based upon standard default assumptions for used for residents. For fishers and recreational visitors, the RME duration will be assumed to be 33 years, and the CTE duration will be assumed to be 12 years (USEPA 2011b).

Children or adolescents may accompany adults who are fishing or recreating at the Site. Default exposure assumptions vary with age (e.g., higher ingestion rates and lower body weights for young children) and young children have higher exposures relative to other age groups. Therefore, for the RME scenarios for the fishers and recreational visitors, it will be assumed that a portion of the total exposure occurs at these younger life stages.[14] This assumption results in an upper bound RME scenario in which the calculated exposure for any alternative age group over the same chronic duration would be less. Because of the location of the site, the individuals most likely to use the Site are adults. Therefore, for the CTE analysis, only adult exposures will be evaluated.

Differences in activity and intake parameters have been characterized for younger children, older children, and adults. Therefore, exposure parameters are presented separately for young children (ages 1 to < 7), older children (ages 7 to < 18), and adults (ages 18 and older).[15]

Body weights of 19, 50, and 80 kg were selected for the young child, older child, and adult age groups, respectively.

4.2.1.2.2 Direct Contact Parameters

The majority of activity by the fisher is expected to occur along the water's edge so that substantial exposure to Site-related soil is not likely. Therefore, for the fishing scenarios, the fraction of total intake that is attributed to Site-related soils will be assumed to be zero, while the fraction of total daily intake from sediment will be assumed to be 1.0 (100 percent). It is envisioned that the recreational visitor spends equal amounts of time in contact with soils and sediments. Therefore, the fraction of pathway exposure to soils and the fraction of pathway exposure to sediments are both assumed to be 0.5. The uncertainties associated with these assumptions will be explored as part of the uncertainty evaluation that will be completed for the BHHRA.

Based on USEPA's (2011b) recommended ingestion rates for soil, soil and sediment ingestion rates of 20 mg/day will be adopted for adults. This rate will be used to evaluate both CTE

[14] The earliest age that exposure is assumed to occur via the potentially complete pathways for this receptor is 1 year.

[15] For scenarios where multiple age groups are outlined, ADDs will be calculated for each age group individually. LADD will be calculated as a sum of intakes across all age groups.

and RME estimates. An ingestion rate of 50 mg/day will be adopted for older children. For younger children, a weighted average rate of 125 mg/day will be used.[16]

For the skin surface area parameter, based on the assumption that an individual's hands, forearms, lower legs, and feet may come into contact with soil and/or sediment, surface areas of 6,080 and 4,270 cm^2, will be used for the older child and adult, respectively (USEPA 2011b). For young children playing in the soil and/or sediment, it is assumed that the entire surface area of the leg may be in contact with sediments in addition to the hands, forearms, and feet. Based on this assumption, the surface area of 3,280 cm^2 will be used (USEPA 2011b).

Weighted sediment adherence factors of 3.6, 5.1, and 4.9 mg/cm^2 for young children, older children, and adults, respectively, were derived based on a study of children playing in sediment (USEPA 2011b). Using data which describes the adherence of soils to skin in adults participating in a variety of activities (USEPA 2011b), a soil adherence factor of 0.07 mg/cm^2 was derived for older children and adults. Data from a study conducted in children exposed to soil were used to derive a soil adherence factor of 0.09 mg/cm^2 for young children (USEPA 2011b).

The exposure frequencies for direct contact pathways can be based on estimates of the number of trips to the site each year. The derivation of the assumption to be used for this parameter differs for recreational fishers, subsistence fishers, and recreational visitors.

According to the 2006 survey of Texas anglers conducted by the U.S. Fish and Wildlife Service (USFWS), the mean number of days spent fishing marine waters by Texas residents was 13 days/year (USFWS 2008). While the USFWS data presentation does not provide the full range of values, it is reasonable to assume that more avid anglers may fish with a higher frequency than the average. A survey conducted of Maine's freshwater anglers (Ebert et al. 1993), for which the average frequency of fishing trips was 24 trips per year, found that the 95th percentile frequency was 70 trips per year (unpublished data), or nearly triple the mean

[16] Rates for the older child and young child are for the RME scenario. There is no child component considered in the CTE scenario for the recreational fisher and visitor. No CTE evaluation will be completed for the subsistence fisher.

frequency. If it is assumed that more avid Texas marine anglers also fish at three times the average rate, this would result in an upper bound trip frequency of 39 trips per year. Based on this information, CTE and RME frequencies for the recreational fisher will be 13 and 39 days/year, respectively.

No quantitative data exist with which to quantify the number of trips (or exposure frequency) for hypothetical subsistence fishers. It is reasonably anticipated that subsistence fishers may participate in fishing activities more often than recreational fishers; however, it is not likely that they would fish the same location more than an average of 2 days per week on average, every week of the year, over the entire exposure duration of 33 years. In addition it is conservatively assumed that 100 percent of the sediment ingested or contacted during the day on which fishing occurs is derived from the Site. This is not likely to be the case because these individuals will spend a portion of those days elsewhere and thus a fraction of the soil/sediment contacted will not be Site-related. Therefore, based on best professional judgment, a value of 104 days per year, which is an average of 2 days per week throughout the year, was selected as the exposure frequency for the subsistence fisher.

In the absence of data concerning recreational use of the Site, RME and CTE frequencies of 104 and 52 days per year, respectively, will be assumed for recreational visitors. These are based on assumed average frequencies of 2 days per week and 1 day per week throughout the course of the year, respectively.

It is not anticipated that a fisher's or visitor's direct contact with soils/sediments would typically be limited to the Site. These individuals would likely not spend the entirety of each day that they fish at the Site; rather they might spend only a few hours and also participate in other activities away from the Site where they will be exposed to sediment or soils. However, no site specific information is available with which to estimate the fraction of total daily soil/sediment intake that is Site-related. Based on best professional judgment, a conservative fractional intake of 1.0 will be adopted for the RME. A fractional intake of 0.5 will be adopted for the CTE.

4.2.1.2.3 Fish and Shellfish Intake Parameters

Consumption of fish and shellfish is defined as a potentially complete pathway for fishers only. Ingestion rates and the fraction of tissue intake that is Site-related are discussed below for these two receptors.

Ingestion Rates

Recreational Fisher

USEPA's (2011b) Exposure Factors Handbook recommends age-specific mean and 95th percentile rates of consumption of recreationally caught marine fish for anglers who fish the Gulf Coast. For adults, the recommended mean and 95th percentile values are 7.2 and 26 g/day, respectively. These recommendations are based on the results of a survey of coastal areas throughout the continental United States conducted by the National Marine Fisheries Service (NMFS 1993). USEPA (2011b) segregated the NMFS (1993) data by region in developing these region-specific rates.

To derive consumption rates, NMFS (1993) adjusted the total mass of fish caught by a very conservative edible fraction of 50 percent to calculate the edible mass of fish consumed. They then used an average family size of 2.5 individuals to address sharing of the consumed fish within the household and derive daily rates on a per-person basis.

All coastal states in the U.S. were included in the survey with the exception of Texas and Washington. While it is likely that the rates derived for Gulf waters in Texas would be similar to rates derived for other Gulf states, the lack of Texas-specific data contributes some uncertainty about the appropriateness of applying these data to Texas anglers. In addition, the survey made assumptions about family size based on census data, rather than angler-specific data, in order to address sharing of the fish within the household. This is an assumption that also introduces some uncertainty into the rates.

A Texas-specific study of fishing activity and consumption was conducted in Lavaca Bay (Alcoa 1998). Lavaca Bay, which covers roughly 40,000 acres, is part of the larger Matagorda Bay system. This system is similar in size to Galveston Bay and is situated further south along the Texas coastline. The demographics in the counties surrounding the two bays are similar (2010 Census data for Calhoun, Chambers, Galveston, Harris, Jackson, and Victoria counties).[17]

Initially, four populations were identified as having potential for exposure to chemical constituents through the ingestion of Lavaca Bay fish. These included the following:

- Subsistence populations
- Non-anglers within the general population who consumed commercially caught fish from Lavaca Bay
- Recreational anglers
- Commercial shrimpers.

As part of its Health Consultation for the Alcoa Site, TDH (1996) evaluated the fishing habits of Vietnamese shrimpers who fished out of Lavaca Bay because there was concern that they might represent a potential subsistence population. TDH conducted a door-to-door survey of this population and concluded that they were not at risk because their shrimping activities generally occurred outside of Lavaca Bay. The findings indicated that no true subsistence fishing activity was occurring within Lavaca Bay.

To address the potential exposure of recreational anglers, Alcoa (1998) conducted two surveys. A general population study was first conducted to help focus the angler survey effort. Then, the Texas Saltwater Angler survey was conducted to collect the necessary data about consumption rates, fraction ingested from the contaminated source, and the species composition of the fish consumed. This survey was conducted in 1994 during the month of November, which was reported to be the month of highest fishing activity in the bay (Alcoa 1998). It included an initial mailing of survey materials to anglers in the three counties surrounding Lavaca Bay, followed by telephone interviews with those anglers. It was specifically conducted to support a risk assessment for the Alcoa Point Comfort/Lavaca Bay Superfund Site. Nearly 2,000 anglers participated in that study.

Alcoa (1998) reported the following mean and 95UCL consumption rates for finfish by age category[18]:

[17] http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml

- Adult men: mean – 24.8 g/day; 95UCL – 27.7 g/day
- Adult women: mean – 17.9 g/day; 95UCL – 19.7 g/day
- Women of childbearing age: mean – 18.8 g/day; 95UCL – 22.1 g/day
- Youths: mean – 15.6 g/day; 95UCL – 17.8 g/day
- Small children: mean – 11.4 g/day; 95UCL – 14.2 g/day.

The study reported the following shellfish consumption rates by age category:

- Adult men: mean – 1.2 g/day; 95UCL – 1.6 g/day
- Adult women: mean – 0.8 g/day; 95UCL – 1.1 g/day
- Women of childbearing age: mean – 0.9 g/day; 95UCL – 1.2 g/day
- Youths: mean – 0.7 g/day; 95UCL – 1.0 g/day
- Small children: mean – 0.4 g/day; 95UCL – 0.6 g/day.

The upper bound values are similar to but slightly higher than the rates recommended by USEPA (2011b) for the Gulf Coast region; however, the mean rates are quite a bit higher than USEPA's recommended means.

These ingestion rates for finfish and shellfish will be adopted for the recreational fisher for the BHHRA. They were selected because they are Texas-specific and represent consumption from a fishery that is similar to the fishery associated with the Site. Mean rates will be used for the CTE analysis, while the 95UCL rates will be used for the RME analysis. The average of rates for men and women will be assumed for the adult ingestion rates. The rates provided for youths in the study will be adopted for the older child while the rates provided for small children will be used for the young child.

Subsistence Fisher

USEPA does not provide recommended fish consumption rates for subsistence fishers, and only discusses subsistence in terms of localized Native American and Alaskan native subsistence populations. However, it is possible that there is a subset of fishers who consume fish at the upper end of the fish consumption rate distribution.

[18] The study did not specify the ages of individuals considered in each of the age categories.

The Lavaca Bay study did not identify a true subsistence population, in terms of socioeconomic demographics. However, it did report upper bound rates based on the survey data collected. Using a ranking approach, Alcoa (1998) presented 90^{th} percentile fish consumption rates for the anglers surveyed and 95^{th} percentile shellfish consumption rates. (The 95^{th} percentile rates were reported for shellfish because the overall levels of consumption were very low and thus the 90^{th} percentile of the distribution was also very low.)

The study reported the following 90^{th} percentile consumption rates for finfish:

- Adult men: 68.1 g/day
- Adult women: 47.8 g/day
- Youths: 45.4 g/day
- Small children: 30.3 g/day.

The study reported the following 95^{th} percentile consumption rates for shellfish:

- Adult men: 5.1 g/day
- Adult women: 2.4 g/day
- Youths: 4.5 g/day
- Small children: 2.0 g/day.

These rates were selected for the finfish and shellfish ingestion rates to be used in evaluating exposures to subsistence fishers for the BHHRA. The average of rates for men and women will be assumed for the adult ingestion rates. The rates provided for youths in the study will be adopted for the older child while the rates provided for small children will be used for the young child.

Fraction of Tissue Intake That Is Site-Related

Recreational Fisher

Given the relatively small spatial extent of the Site compared with the size of the Galveston Bay fishery, it is unlikely that 100 percent of the fish consumed over the 33 year exposure duration assumed for the RME will be harvested from the Site. This is demonstrated by survey data for Lavaca Bay. Of interest to the risk assessors who conducted the survey was information about the locations where fish were harvested so that it would be possible to determine the fraction of fish taken from the 1,500 acre subarea (indicated as the closure area), the fraction taken from other portions of Lavaca Bay, and the fraction taken from other areas outside of Lavaca Bay.

Similar to conditions at Lavaca Bay, the waters associated with the SJRWP Site represent a very small fraction of the Galveston Bay fishery. Also like Lavaca Bay, there are many other locations around Galveston Bay that can be used for fishing. Thus, the fraction of fish actually consumed from waters on the Site is likely to be limited.

The survey conducted by Alcoa (1998) at Lavaca Bay segregated the consumption data by the areas fished; specifically, the closure area, other portions of Lavaca Bay, and areas outside of Lavaca Bay. The study reported averages of 0.6 and 8.5 percent of finfish consumed were collected from the 1,500 acre closure area and Lavaca Bay, respectively. It reported 95UCLs of 0.9 and 9.7 percent of finfish consumed were collected from the closure area and Lavaca Bay, respectively. The majority of finfish consumed (i.e., approximately 90 percent) were obtained from areas outside of Lavaca Bay. The study reported averages of 0 and 0.1 percent of shellfish consumed were from the closure area and Lavaca Bay, respectively. 95UCLs of 0 and 0.2 percent of shellfish consumed were collected from the closure area and Lavaca Bay respectively. More than 99 percent of shellfish consumed were from areas outside of Lavaca Bay.

The fraction of total fish consumed from Lavaca Bay is a reasonable estimate of fish and shellfish consumption from a single fishing area, and will be used to estimate the fraction of total tissue consumed by recreational anglers that is derived from the Site. Both the mean and the 95UCL for fractional intake of finfish in the closure area within Lavaca Bay are less than 10 percent, and the fraction of shellfish consumed from the area is even lower, at less than one percent. Considering these data, 10 percent will be used for the CTE fractional Site-related intake for both finfish and shellfish in the BHHRA. There may be some differences between the fishing patterns that occur at Lavaca Bay compared to Galveston Bay and the Site, and therefore, a more conservative value of 25 percent will be adopted for the RME fractional Site-related intake for finfish and shellfish.

Subsistence Fisher

There is no site-specific information available with which to estimate the fractional intake of fish and shellfish from the Site for the subsistence fisher. If subsistence activities do occur at the Site, it is possible that fishers participating in these activities may stay within closer proximity to the Site. Given the lack of Site-specific information, a conservative fractional intake of 1.0 will be adopted for the subsistence fisher.

4.2.2 *South Impoundment Area*

This section details the specific exposures that will be characterized and the exposure assumptions that will be adopted in the BHHRA for the south impoundment area.

4.2.2.1 Receptor Groups and Exposure Scenarios

Trespassers and workers are the human receptors for this area. Trespassers may walk around or spend time recreating within the south impoundment area. Workers may perform maintenance or other activities that may involve contact with soil. Potentially complete exposure pathways to be evaluated in the BHHRA for these groups include direct ingestion of and dermal contact with soil.

Table 7 presents the exposure scenarios that will be characterized in the BHHRA for the south impoundment area. The scenarios capture all of the potentially complete and significant exposure pathways described above and the exposure units for soil established in Section 3.4. They are:

- Trespasser—direct contact (i.e., ingestion of and dermal absorption) with surface soils at the single soil exposure unit defined.
- Worker—direct contact (i.e., ingestion of and dermal absorption) with surface and shallow subsurface soils at the single soil exposure unit defined.

4.2.2.2 Exposure Assumptions for Trespasser Scenario

USEPA does not offer specific guidance regarding the evaluation of exposures to trespassers for human health risk assessment. For the purposes of the BHHRA, it is assumed that the trespasser is an adolescent or young adult between the ages of 16 and 22 years, who occasionally visits the south impoundment area. Exposure assumptions for the trespasser are summarized in Table 11.

The exposure duration for the trespasser is related to the assumed age group. For the RME, it will be assumed that the trespasser visits the Site from age 16 to < 23 (7 years), whereas for the CTE, it will be assumed that the trespasser visits the Site for approximately half of that duration (4 years).

The mean body weight of 74 kg for males and females age 16 to < 23 will be assumed (USEPA 2011b). Based on the assumption that a trespasser's hands, forearms, lower legs, and feet may come into contact with soils during time at the Site, a surface area value of 5,550 cm^2 will be used. A weighted soil adherence factor of 0.07 mg/cm^2, based on data from a study of adults exposed to soil via a variety of types of contact activities, will be adopted (USEPA 2011b). A soil ingestion rate of 41 mg/kg will be used based on USEPA's (2011b) recommended soil ingestion rate of 50 mg/day for individuals ages 1 to < 21 years, and 20 mg/kg for individuals age 21 and older.

In the absence of any specific information about trespassing in the south impoundment area, exposure frequencies of 24 days/year and 12 days/year (i.e., an average of 2 days per month and 1 day per month throughout the course of the year) will be used to evaluate RME and CTE estimates, respectively. Considering the largely inaccessible nature of the south impoundment area, this assumption is reasonable. No site specific information (e.g., such as the amount of time trespassers spend at the Site for each visit they make) is available to inform the fraction of total daily soil exposure that is Site-related. In the instance that an individual does trespass on the Site, it is anticipated that his or her stay would be for only a few hours at most, and that the individual would also participate in other activities away from the Site where he or she would be exposed to soil. Based on best professional judgment, a fractional intake for direct contact with soil of 0.5 will be used for the RME analysis. A fractional intake of 0.25 will be used to evaluate the CTE.

4.2.2.3 Exposure Assumptions for Worker Scenario

For the BHHRA, the assumptions proposed by USEPA (2002d) for an outdoor worker have generally been selected. Exposure assumptions for the worker are summarized in Table 12 and discussed below.

USEPA's (2002c) default exposure duration of 25 years for workers will be used for the RME analysis. Twelve years will be adopted to evaluate CTE estimates, based on best professional judgment. An exposure frequency of 225 days/year for outdoor workers will be used (USEPA 2002c).

Outdoor workers are assumed to be adults and mean body weight for male and female adults of 80 kg will be used (USEPA 2011b). Following USEPA (2002c) guidance, it will be assumed that a worker's head, forearms, and hands may come into contact with Site soils. Based on this assumption, a mean surface area of 3,470 cm^2 was derived. USEPA's (2004) recommended soil adherence factor of 0.2 mg/cm^2 will be adopted. This recommendation is based on data for a wide variety of activities in which an outdoor worker may engage.

Based on the assumption that outdoor workers may be involved in contact-intensive activities, the recommended soil ingestion rate for outdoor workers of 100 mg/day will be used for the RME (USEPA 2002c). Because site workers may also be involved in less intensive activities, a rate of 50 mg/day will be used to evaluate the CTE estimates. This CTE is based on the recommended rate from USEPA (2002c) for an indoor worker.

It is reasonable to assume that workers may spend the majority of their waking hours at the Site so that the daily contribution from other sources may be minimal. Thus, the fractional intake for Site soil will be assumed as 1.0 for both RME and CTE estimates.

4.3 Chemical-Specific Exposure Parameters

In addition to the scenario-specific exposure assumptions described above, there are a number of chemical specific factors that will be used to estimate $COPC_H$-specific exposure levels. These include oral bioavailability and dermal absorption factors and chemical reduction due to preparation and cooking. The chemical specific values selected for each are summarized in Table 15 and discussed below.

4.3.1 *Relative Oral Bioavailability*

Bioavailability refers to the degree to which a substance becomes available to the target tissue after administration or exposure (USEPA 2011c). Following USEPA (1989) guidance, in the absence of data to the contrary, the bioavailability of $COPC_{HS}$ will be assumed to be 1.0.

Relative bioavailability is a measure of the extent of absorption that occurs for different forms of the same chemical (e.g., lead carbonate vs. lead acetate), different vehicles (e.g., food, soil, and/or water), or different dose levels. RBA factors for oral pathways are used to account for the differences in chemical bioavailability in specific exposure media (i.e., soil, sediment, tissue) compared to the dosing vehicle used in the critical toxicity study that provides the basis for the $COPC_{H}$-specific toxicity criteria selected for use in the BHHRA.

For practical reasons, toxicity tests are usually designed using media that are expected to have high levels of bioavailability. The bioavailability of chemicals from other environmental matrices however, can be influenced by external factors such as the form of a compound (e.g., oxidation state), the length of time the chemical has been present (e.g., aging or weathering), and the physical characteristics of the medium (e.g., fraction of organic carbon in soil/sediment). It can also be influenced by internal biological factors such as absorption mechanisms within a living organism.

The relative bioavailability of a chemical in an environmental medium (e.g., soil, sediment, tissue) can be expressed as:

$$RBA = \frac{absorbed\ fraction\ from\ exposure\ medium\ on\ site}{absorbed\ fraction\ from\ dosing\ medium\ used\ in\ toxicity\ study} X\ 100 \qquad \text{(eq. 4-5)}$$

Literature searches were conducted to identify appropriate RBA values for $COPC_{HS}$ that are anticipated to be risk drivers for the BHHRA for soil, sediment, and tissue. No information was available with which to quantify RBA_{tissue}. Thus, in all cases, the RBA_{tissue} will be assumed to be 1.0, or 100 percent. The relative bioavailability of $COPC_{HS}$ in soils and sediments is discussed below.

The RBAs shown in Table 15 will be applied in the BHHRA. Uncertainties associated with the RBAs will be discussed in the uncertainty analysis of the BHHRA.

4.3.2 *Relative Bioavailability of Chemicals in Soils and Sediments*

Although relative bioavailability may differ between sediment and soil, existing data are currently insufficient to determine default RBAs for sediment. In the absence of site-specific information on bioavailability of sediment, USEPA and the Interstate and Technology Regulatory Council recommend that default factors for soil be adopted to evaluate sediment exposures (USEPA 2004; ITRC 2011).

Sufficient data with which to evaluate $RBA_{soil-sediment}$ were available for dioxins and furans and for arsenic. The $RBA_{soil-sediment}$ for each of these $COPC_{HS}$ is discussed below. A conservative default $RBA_{soil-sediment}$ value of 1.0 will be assumed for the remainder of the $COPC_{HS}$ including cadmium, chromium, copper, mercury, nickel, thallium, PCBs, and BEHP. The uncertainty associated with the RBAs selected will be discussed in the uncertainty evaluation to be included in the BHHRA. The impact of alternative assumptions may be quantified for risk-driving $COPC_{HS}$ in soil and sediment.

4.3.2.1 Dioxins/Furans

USEPA (2010c) acknowledges that the relative bioavailability of dioxins and dioxin-like compounds in soils is less than 100 percent. In the Final Report, *Bioavailability of Dioxins and Dioxin-Like Compounds in Soil* USEPA (2010c), USEPA identified six studies that reported a total of 17 RBA test results for 2,3,7,8-TCDD in soil and sediment at concentrations ranging from 1.9 to 2,300 ng/g. The selected studies provided RBA estimates in test materials consisting of soil and sediment contaminated with dioxins *in situ*. The RBA for these studies ranges from less than 1 to 49 percent. Studies of spiked soil materials were not included in the analysis because aging of contaminated soil may decrease the bioavailability of dioxins in soil.

The high end of the soil and sediment concentrations of 2,3,7,8-TCDD and TEQ_{DF} at the Site are within the range included in USEPA's review. Based on these data, an $RBA_{soil\text{–}sediment}$ of 0.5 will be applied for TEQ_{DF} in the BHHRA.

4.3.2.2 Arsenic

The relative bioavailability of inorganic arsenic in soil can vary due to differences in geochemical parameters and absorption mechanisms in receptor species. Several meta-analyses of arsenic bioavailability are available:

- USEPA (2010d) completed *in vivo* tests of 29 test materials from contaminated arsenic and clean sites using the Juvenile Swine Model. The test materials represented a large variety of arsenic phases (e.g., oxides, sulfates, phosphates). Discounting three tests that were determined to be unreliable due to levels of administered arsenic, estimated RBA values ranged from less than 10 to 61 percent with a mean of 34 percent Based on these findings USEPA Region 8 concluded that an RBA of 0.50 as a generally conservative default value for inorganic arsenic (USEPA 2011d).
- Bioavailability studies conducted by Roberts et al. (2007) in cynomolgus monkeys measured the bioavailability of arsenic in 14 soil samples from 12 different sites, including mining and smelting sites, pesticide facilities, cattle dip vat soil, and chemical plant soil. The reported RBAs ranged from 5 to 31 percent.

Based on the available information, an $RBA_{soil\text{–}sediment}$ of 0.50 will be used in evaluating oral exposures to soil and sediment in the BHHRA.

4.3.3 *Dermal Absorption Factor for Soil and Sediment*

The dermal absorption factor represents the proportion of a chemical that is absorbed across the skin from the soil and/or sediment matrix once contacted. Skin permeability is related to the solubility or strength of binding of the chemical in the soil or sediment matrix compared to the skin's *stratum corneum*. Therefore, dermal absorption is dependent on the properties of the chemical itself, as well as external factors including the physical properties of the soil or sediment matrix (e.g., particle size and organic carbon content) and the conditions of the skin (e.g., skin condition, moisture content).

Data with which to characterize dermal absorption of chemicals from sediment is not readily available and dermal absorption of chemicals from soil and sediment matrices will differ to some degree. In the absence of sediment-specific information, USEPA (2004) supports the adoption of factors derived for soil being applied to sediment.

USEPA's RAGS E Dermal Guidance (USEPA 2004) recommends dermal absorption factors for 10 chemicals for which well-designed studies were available at the date of its publication. In addition to USEPA's dermal guidance, sources including guidance from other regulatory entities and the peer reviewed literature were reviewed for available factors.

Dermal absorption factors for dioxins and furans, arsenic, PCBs, and BEHP were obtained from USEPA (2004). Those for chromium, mercury, and nickel were obtained from the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment's (OEHHA) Technical Support Document for Exposure Assessment and Stochastic Analysis, Draft (CalEPA 2011).

Following USEPA (2004) guidance, in the absence of available data for copper, thallium, and zinc, a conservative dermal absorption factor of 1.0 will be assumed for these $COPC_{HS}$.

There is a degree of uncertainty in the representativeness of these dermal absorption factors for estimating potential exposure at the Site. Some of the more significant sources of uncertainty, focused around the $COPC_{HS}$ that are likely to drive risk at the Site, are discussed here.

- Observed ranges in absorption factors for a single chemical from different studies demonstrate large variability. For example, for PCBs, the default dermal absorption factor selected by USEPA and OEHHA is 14 percent. Another study (Mayes et al. 2002) that employed a similar methodology reported absorption ranging from 3 to 4 percent (CalEPA 2011). While some reasons for the large differences reported have been hypothesized, their influence has not been fully characterized.
- Organic carbon content also can have a substantial impact on dermal absorption. A chemical absorbed to the organic carbon phase will generally be less available

for transfer to skin than a chemical present in a separate liquid phase in the soil. Dermal bioavailability of a chemical in soil tends to decrease with increasing organic content of the soil (NEPI 2000; CalEPA 2011). Any difference between the organic carbon content in the test study matrix and at the Site may influence the applicability of the dermal absorption factor to the Site.

- Data for the full spectrum of dioxin-like congeners (i.e., to be evaluated as TEQ_{DF} and TEQ_{P}) is not available. The dermal absorption factor of 3 percent selected for this group of chemicals is based on a study of 2,3,7,8-TCDD (USEPA 2004). Thus, when the TEQ approach is used, it is inherently assumed that the absorption of all dioxin-like congeners is the same as the absorption of 2,3,7,8-TCDD. However, given differences in the chemical structure and properties of these compounds, it is likely that the degree of absorption differs substantially among them.

The dermal absorption factors shown in Table 15 will be applied in the baseline risk assessment. Uncertainties associated with the absorption factors used will be assessed in the uncertainty evaluation to be completed as part of the BHHRA.

4.4 Chemical Reduction Due to Preparation and Cooking

It is well recognized that tissue preparation and cooking methods used may reduce chemical concentrations in fish tissues, particularly for lipophilic compounds such as dioxins, furans, and PCBs (USEPA 2000a, 2002d; Wilson et al. 1998). These changes are dependent on a number of factors: the lipophilicity of the compound, the specific preparation and cooking method used by the consumers, the type of fish, and the parts of the fish consumed.

Specific information on the cooking methods used by fishers who catch and consume fish and shellfish at the Site has not been quantified. In addition, as discussed previously, species preferences for catch, harvest, and consumption at the Site have not been fully characterized.

Appendix C-1 of USEPA's Guidelines for Assessing Chemical Contamination Data for Use in Fish Advisories presents data on chemical loss due to preparation and cooking activities based on data from more than two dozen studies (USEPA 2000a). Reported cooking losses are highly variable depending on the chemical, study, species, and preparation and cooking methods used. Loss for PCBs and dioxins for a wide array of preparation and cooking methods in a variety of tissue types ranged from 0 to 78 percent for PCBs, and 40 to 80 percent for dioxins. More recently available studies also report large ranges for cooking loss.

Although cooking loss appears to occur, the extent of dioxin, furan, and PCB cooking loss that occurs has not been well characterized in the published literature, and quantitative estimates of cooking losses remain uncertain. There were no consistent differences in losses among cooking methods in the studies reviewed. The range of methodologies used and differences in reporting likely explain some inconsistencies in the results. However, based on the available data, it is not possible to quantify the importance of specific factors influencing the extent of cooking losses for these chemicals.

Given the large degree of uncertainty in preparation and cooking methods used at the Site, coupled with the large degree of uncertainty and variability in actual loss via different preparation and cooking methods, a cooking loss term of 0 will conservatively be assumed for PCBs and dioxins. The impact of this assumption will be considered in the uncertainty evaluation to be completed as part of the BHHRA. The impact of using a cooking loss of 0.25 (25 percent loss) will be explored. This value is in line with cooking loss factors that have been developed for sites where more specific information on consumption and cooking methodologies are known (i.e., the Housatonic River Site).

5 IMPLEMENTATION OF PROBABILISTIC EXPOSURE ASSESSMENT

This section describes the use of probabilistic methods for estimating exposure at the Site. Specifically, it discusses the circumstances under which a probabilistic risk analysis (PRA) will be implemented, and the general approach that will be used in determining the specific parameters to be examined in the PRA. In addition, it presents, in general terms, the approaches that will be used in developing input distributions for exposure parameters.

5.1 Use of Probabilistic Methods

Probabilistic analysis can provide a more complete and transparent characterization of exposure than a deterministic analysis. In probabilistic exposure assessment, data distributions are used to describe one or more exposure parameters. Multiple iterations of the risk equation are run, using different combinations of parameters to present a probability distribution of estimated exposure. The probabilistic output provides a more complete presentation of potential exposure and risk by considering both variability and uncertainty in parameter estimates, and ultimately offers insight into both the magnitude and probability of exposure.

USEPA recognizes that while a probabilistic assessment adds value for characterizing exposure in some cases, it may not be warranted in others. Factors to consider in deciding whether to proceed with a probabilistic assessment include 1) the results of the deterministic risk assessment, 2) the degree of variability and uncertainty associated with the input parameters, and 3) the potential impacts of the identified variability and uncertainty on overall estimates of exposure and risk.

Whether to implement a probabilistic analysis for the Site, and the specific exposure scenarios, pathways and parameters to be evaluated in that analysis will be dependent on the results of the deterministic BHHRA and the sensitivity and uncertainty analysis. Sensitivity analysis consists of evaluating the variation in output of a model following changes in the values of the model's input(s) (USEPA 2001). A sensitivity analysis allows the impact of individual parameter assumptions and their alternatives to be characterized in a systematic manner.

If the RME risk estimate (upper bound) associated with an exposure scenario is less than $1x10^{-4}$ and/or the hazard index is less than 1.0, a PRA will not be completed for that scenario. In addition, when the estimated risks or hazards resulting from a pathway that contributes significantly to risk or hazard are not greater than background risks, a probabilistic assessment will not be conducted.

If risks associated with the upper bound exposure estimates for a given scenario are unacceptable, however, the results of the CTE estimate and sensitivity analyses will be used to determine the impact that variability in exposure parameters has on the final risk estimate. If critical parameters that substantially influence the estimated exposures and associated risk are identified by the sensitivity analysis, a PRA may be conducted for one or more of the exposure pathways associated with that scenario. If completed, the PRA will be included as part of the BHHRA and considered in subsequent phases of the RI/FS.

5.2 Approach

Any probabilistic assessment completed will be performed in a manner consistent with USEPA (2001) guidance for conducting PRA. If conducted, the probabilistic assessment will focus on the parameters that have the largest impacts on the overall estimates of exposure and risk. These may be factors that are have a large range of potential values or be factors that have a substantial effect on the overall exposure estimate when combined with other factors (i.e., factors that are multiplicative). Distributions for these critical parameters will be developed using information obtained from the peer-reviewed literature.

It is anticipated that the fish and/or shellfish consumption pathways will play an important role in the overall risks for the Site. Therefore, it is likely that these pathways, if any, may be candidates for a more detailed probabilistic evaluation for some $COPC_{HS}$. For the tissue consumption pathways, the critical parameters that are likely to warrant the development of input distributions include fish/shellfish ingestion rates, consumption preferences (which influence EPCs), fractional intake of fish and shellfish associated with the Site, preparation and cooking methods (which influence cooking loss), the cooking loss term itself, and the exposure duration.

6 SUMMARY

This EAM provides an overview of the methods that will be used to estimate exposures to $COPC_{HS}$ by people who use the Site. It reviews the conceptual framework of pathways to be considered within the BHHRA, outlines the chemistry data considered representative for evaluating human exposures, and discusses the manner in which EPCs will be calculated. It additionally presents the exposure equations and general and chemical-specific parameters that will be used to estimate intake. Ultimately, these estimated intakes will be combined with toxicity criteria described in the Toxicological and Epidemiological Studies Memorandum (Integral 2012) to calculate risks and hazards at the Site.

Comments from USEPA on this draft EAM will be incorporated into a final EAM that will ultimately be included as an appendix to the draft BHHRA Report, which is scheduled to be delivered in July 2012.

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TABLES

Table 1
Chemicals of Potential Concern for Human Health

$COPC_H$
Dioxins/Furans
Dioxins and Furans
Metals
Arsenic
Cadmium
Chromium
Copper
Mercury
Nickel
Thallium
Zinc
Polychlorinated Biphenyls
Polychlorinated Biphenyls
Semivolatile Organic Compounds
Bis(2-ethylhexyl)phthalate

Notes

$COPC_H$s shown are for the area north of I-10 and the aquatic environment. Selection of $COPC_H$s for the south impoundment area is in progress at the time of this submittal (Jan. 2012). Although thallium is not a $COPC_H$ according to analyses of information for the north impoundment, the maximum concentration of thallium measured in the south impoundment area exceeded the screening value for workers and, therefore, may be a $COPC_H$ for the south impoundment. It is therefore addressed in this memorandum.

$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessment

Table 2
Chemicals of Potential Concern

Chemical	COPC Designation
Dioxins/Furans	
Dioxins and Furans	EB, EFW, HH
Metals	
Aluminum	EB
Arsenic	HH
Barium	EB
Cadmium	EFW, HH
Chromium	HH
Cobalt	EB
Copper	EB, EFW, HH
Lead	EB
Magnesium	EB
Manganese	EB
Mercury	EB, EFW, HH
Nickel	EFW, HH
Thallium	EB
Vanadium	EB
Zinc	EB, EFW, HH
Polychlorinated Biphenyls	
Polychlorinated Biphenyls	EFW, HH
Semivolatile Organic Compounds	
Phenol	EB
Carbazole	EB
Bis(2-ethylhexyl)phthalate	EB, EFW, HH

Notes

EB = ecological receptors - benthic invertebrate community
EFW = ecological receptors - fish and wildlife
HH = human health receptors

Table 3
Summary of Data To Be Used in the BHHRA [a]

Area and Medium	Study/Dataset	Sampling Period	Description of Samples Relevant for Human Health [a]	$COPC_H$s Evaluated
On-Site Data for Area North of I-10 and Aquatic Environments				
Sediment	URS 2010 (collected by TCEQ in 2009)	8/2009	Surface samples (0- to 6-inch) in the shoreline area around the north impoundment.	Dioxins/furans
	RI (TCRA)	4/2010	Surface samples (0- to 6-inch) in the north impoundment area.	Dioxins/furans
	RI	5/2010-6/2010 and 10/2010	Surface samples (0- to 6-inch) collected from 5 beach areas to evaluate human exposure. Additional surface samples (0- to 6-inch) collected within the shoreline area of the north impoundment.	Dioxins/furans, arsenic, cadmium, chromium, copper, mercury, nickel, zinc, PCBs (Aroclors and dioxin-like congeners), BEHP
Soil	RI (TxDOT ROW)	8/2010	Surface samples (0- to 6-inch; 0- to 8-inch; 0- to 12-inch) collected alongside I-10.	Dioxins/furans, arsenic, cadmium, chromium, copper, mercury, nickel, zinc, PCBs (Aroclors and dioxin-like congeners), BEHP
	RI (TCRA BSS)	11/2010	Surface samples (0- to 6-inch) collected to the west of the north impoundment.	Dioxins/furans, arsenic, cadmium, chromium, copper, mercury, nickel, zinc, PCBs (Aroclors), BEHP
	RI (Groundwater study)	12/2010-1/2011	Surface samples (0- to 6-inch) collected in the area between I-10 and the north impoundment area.	Dioxins/furans, arsenic, cadmium, chromium, copper, mercury, nickel, zinc, BEHP
	RI	2/2011	Surface samples (0- to 6-inch) collected throughout the area north of I-10.	Dioxins/furans, arsenic, cadmium, chromium, copper, mercury, nickel, zinc, BEHP
Tissue	Univeristy of Houston and Parsons (2009)	5/2008, 8/2008, 5/2009	Atlantic croaker fillet(skin removed), Blue catfish fillet, and Hardhead catfish fillet (skin removed) from a single location within FCA 1. [b]	PCBs (congeners)
	RI	10/2010	Hardhead catfish fillet (skin removed), Blue crab (edible tissue) and Rangia cuneata clams (soft tissue) from 3 FCAs.	Dioxins/furans, arsenic, cadmium, chromium, copper, mercury, nickel, zinc, PCBs (congeners), BEHP
On-Site Data for South Impoundment Area				
Soil	RI (Phase I)	3/2011	Co-located surface and shallow subsurface samples (0- to 6-inch, 6- to 12-inch) collected at a subset of locations. Deeper surface samples (0 to 2 feet) collected at a subset of locations.	All COPCs (see Table 2)
	RI (Phase II)	planned for 2/2012	Co-located surface and shallow subsurface samples (0- to 6-inch, 6- to 12-inch).	Dioxin/furans. Potential for all COPCs (see Table 2) from archived soil.
Background Data				
Sediment	RI	5/2010, 8/2010, and 10/2011	Surface samples (0- to 6-inch) collected upstream of the Site.	Dioxins/furans, arsenic, cadmium, chromium, copper, mercury, nickel, zinc, PCBs (Aroclors and dioxin-like congeners), BEHP [c]
Soil	RI	2/2011	Co-located surface and shallow subsurface samples (0- to 6-inch, 6- to 12-inch) collected from two public parks.	Dioxins/furans, arsenic, cadmium, chromium, copper, mercury, nickel, zinc, BEHP

Table 3

Summary of Data To Be Used in the BHHRA [a]

Area and Medium	Study/Dataset	Sampling Period	Description of Samples Relevant for Human Health [a]	$COPC_H$s Evaluated
Tissue	Univeristy of Houston and Parsons (2009)	5/2008 - 8/2008, 5/2009	Hardhead catfish fillet collected downstream of the Site (locations downstream of the Fred Hartman bridge and additional samples located ~1,000 feet upstream of the Fred Hartman Bridge). [c]	PCBs (congeners)
	RI	10/2010 and 10/2011	Hardhead catfish fillet (skin removed), blue crab (edible) collected downstream of the Site; *Rangia cuneata* clams (soft tissue) collected from an upstream area.	Dioxins/furans, arsenic, cadmium, chromium, copper, mercury, nickel, zinc, PCBs (congeners), BEHP [d]

Notes

BEHP = bis(2-ethylhexyl)phthalate
BHHRA = baseline human health risk assessment
$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessment
FCA = fish collection area
PCB = polychlorinated biphenyl
RI = remedial investigation
TCRA = time critical removal action
TxDOT ROW = Texas Department of Transportation right-of-way

a - All data to be used for the BHHRA are of Category 1 data validation. Data collected prior to 2005 were not included given the results of an analysis that showed sediment chemistry has changed since then. Only data relevant for the BHHRA (e.g., representative sample locations and depths to evaluate human exposures) are described.

b - Hardhead catfish fillet data will be included in the quantitative BHHRA based on the results of statistical tests to determine the appropriateness of pooling with data collected for the RI. See text in Section3.4.2 Other tissue types will be considered in qualitative evaluations.

c - The inclusion of samples from two additional locations will increase the sample size so that a more robust exposure point concentration for hardhead catfish from this dataset to be calculated.

d - A subset of samples were analyzed for dioxins and furans only.

Table 4
Mammalian Toxicity Equivalency Factors for PCDDs, PCDFs, and PCBs

Compound	TEF
PCDDs	
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
All HxCDDs	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0003
PCDFs	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.03
2,3,4,7,8-PeCDF	0.3
All HxCDFs	0.1
All HpCDFs	0.01
OCDF	0.0003
PCBs	
3,3’,4,4’-Tetrachlorinated biphenyl (PCB-77)	0.0001
3,4,4’,5-Tetrachlorinated biphenyl (PCB-81)	0.0003
3,3’,4,4’,5-Pentachlorinated biphenyl (PCB-126)	0.1
3,3’,4,4’,5,5’-Hexachlorinated biphenyl (PCB-169)	0.03
2,3,3’,4,4’-Pentachlorinated biphenyl (PCB-105)	0.00003
2,3,4,4’,5-Pentachlorinated biphenyl (PCB-114)	0.00003
2,3’,4,4’,5-Pentachlorinated biphenyl (PCB-118)	0.00003
2’,3,4,4’,5-Pentachlorinated biphenyl (PCB-123)	0.00003
2,3,3’,4,4’,5-Hexachlorinated biphenyl (PCB-156)	0.00003
2,3,3’,4,4’,5’-Hexachlorinated biphenyl (PCB-157)	0.00003
2,3’,4’4’,5,5’-Hexachlorinated biphenyl (PCB-167)	0.00003
2,3,3’,4,4’,5,5’-Heptachlorinated biphenyl (PCB-189)	0.00003

Source

Van den Berg et al. (2006)

Notes

PCB = polychlorinated biphenyl
PCDD = polychlorinated dibenzo-*p* -dioxin
PCDF = polychlorinated dibenzofuran
TEF = toxicity equivalency factor
TCDD/TCDF = tetrachlorinated dibenzo dioxins/furans
PeCDD/PeCDF = pentachlorinated dibenzodioxins/furans
HxCDD/HxCDF = hexachlorinated dibenzodioxins/furans
HpCDD/HpCDF = heptachlorinated dibenzodioxins/furans
OCDD/OCDF = octachlorinated dibenzodioxins/furans

Table 5
PCB Congeners for Inclusion in Total PCB Summation

PCB-8	PCB-81	PCB-128	PCB-177
PCB-18	PCB-87	PCB-138	PCB-180
PCB-28	PCB-99	PCB-151	PCB-183
PCB-37	PCB-101	PCB-153	PCB-187
PCB-44	PCB-105	PCB-156	PCB-189
PCB-49	PCB-110	PCB-157	PCB-194
PCB-52	PCB-114	PCB-158	PCB-195
PCB-66	PCB-118	PCB-167	PCB-201
PCB-70	PCB-119	PCB-168	PCB-206
PCB-74	PCB-123	PCB-169	PCB-209
PCB-77	PCB-126	PCB-170	

Notes
PCB = polychlorinated biphenyl

Table 6
Summary of Exposure Units for the BHHRA

Medium		Scenario (Pre/Post TCRA)	Defined Exposure Unit	Sample Locations Included	Sample Depths Included	Number of Sampling Locations [a]	Detection Frequency for Exposure Unit	Figure Displaying Exposure Unit
Area North of I-10 and Aquatic Environments								
Sediment		Pre-TCRA	Beach Area A	SJSH036, -038, -040, -042, -044	0- to 6-inch	5	See Table D-1	Figure 7
			Beach Area B/C	SJSH017, -019, -021, -023, -025, -027, -029, -031, -033, -035	0- to 6-inch	10	See Table D-1	Figure 7
			Beach Area D	SJSH001, -002, -003, -004, -005, -012, -014	0- to 6-inch	7	See Table D-1	Figure 7
			Beach Area E	SJSH008, -009, -010; SJGB001, -006, -009, -010, -011, -012; SJNE022-1, -022-2, and -022-3; SJSV001; Point #1&2, Point #3; SJA1, SJA2	0- to 6-inch	17	See Table D-1	Figure 7
		Post-TCRA	Beach Area A	SJSH036, -038, -040, -042, -044	0- to 6-inch	5	See Table D-1	Figure 8
Tissue	Hardhead catfish fillet	Pre-TCRA	FCA 1	SJFCA1-LF1 to -LF 10, 11193	--	13	See Table D-2	Figure 9
			FCA 2/3	SJFCA2-LF1 to -LF 10; SJFCA3-LF1 to -LF 10	--	20	See Table D-2	Figure 9
	Edible clam	Pre-TCRA	FCA 1/3	CL-TTR1-001 to -005; CL-TTR6-001 to -005	--	10	See Table D-2	Figure 9
			FCA 2	CL-TTR3-001 to -005; CL-TTR4-001 to -005; CL-TTR5-001 to -005	--	15	SeeTable D-2	Figure 9
	Edible crab	Pre-TCRA	FCA 1	SJFCA1-CR1 to -CR10	--	10	See Table D-2	Figure 9
			FCA 2/3	SJFCA2-CR1 to -CR10; SJFCA3-CR1 to -CR10	--	20	See Table D-2	Figure 9
	All Types	Post-TCRA	Exposure units corresponding with pre-TCRA	No samples, modeled value	--	--	--	--
Soil		Pre-TCRA	Soils North of I-10	SJMWS01, -02, -03; SJTS001 to -031; TxDOT001 to -012	0- to 6-, 0- to 8-, and 0- to 12-inch	46	See Table D-3	Figure 10
		Post-TCRA	Soils North of I-10 $_{POST\text{-}TCRA}$ [b]	SJTS028 to -031; TxDOT001, -007	0- to 6-inch	6	See Table D-3	Figure 11

Table 6
Summary of Exposure Units for the BHHRA

Medium	Scenario (Pre/Post TCRA)	Defined Exposure Unit	Sample Locations Included		Sample Depths Included	Number of Sampling Locations [a]	Detection Frequency for Exposure Unit	Figure Displaying Exposure Unit
South Impoundment [c]								
Soil	Pre-and Post-TCRA	Soils South of I-10	SJSB001 to -027; SJTS032 to -034		0- to 6-inch, 6- to 12-inch,[d] 0- to 2-foot	30	See Table D-4	Figure 12

Notes

-- = not applicable
BHHRA = baseline human health risk assessment
$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessment
CWA = Coastal Water Authority
TCRA = time critical removal action

a - Sample size is across all analytes. Some $COPC_H$s are sampled at a lower frequency. $COPC_H$-specific detection frequency tables are provided in Appendix D.
b - Fencing constructed as part of the TCRA and by CWA limits accessible soils and sediments.
c - Phase I and Phase II sample locations are included here. Phase II sampling has not been completed at the time of this submittal (January 2012).
d - 0- to 6-inch and 6- to 12-inch samples are co-located. These two depths will be averaged, and the depth weighted average used for exposure assessment for workers. Only surface samples will be considered for trespassers.

Table 7
Summary of Exposure Scenarios for the BHHRA for Each Area

Scenario [a]			Sediment EU(s)	Soil EU(s)	Finfish EU(s)	Shellfish EU(s)
			Exposure Unit (EU) [b]			
Area North of I-10 and Aquatic Environments						
Fisher (Recreational and Subsistence)						
Pre-TCRA	Scenario 1A		Beach Area A	--	Hardhead Catfish: FCA 2/3	--
	Scenario 1B		Beach Area A	--	--	Clam: FCA 1/3
	Scenario 1C		Beach Area A	--	--	Crab: FCA 2/3
	Scenario 2A		Beach Area B/C	--	Hardhead Catfish: FCA 2/3	--
	Scenario 2B		Beach Area B/C	--	--	Clam: 2
	Scenario 2C		Beach Area B/C	--	--	Crab: FCA 2/3
	Scenario 3A		Beach Area E	--	Hardhead Catfish: FCA 2/3	--
	Scenario 3B		Beach Area E	--	--	Clam: 2
	Scenario 3C		Beach Area E	--	--	Crab: FCA 2/3
	Scenario 4A		Beach Area D	--	Hardhead Catfish: FCA 1	
	Scenario 4B		Beach Area D	--	--	Clam: FCA 1/3
	Scenario 4C		Beach Area D	--	--	Crab: FCA 1
Post-TCRA	Scenario 1		Beach Area A	--	Modeled values will be used, see text in Section 3.5.2	
Recreational Visitor						
Pre-TCRA	Scenario 1		Beach Area A	Soils North of I-10	--	--
	Scenario 2		Beach Area B/C	Soils North of I-10	--	--
	Scenario 3		Beach Area E	Soils North of I-10	--	--
	Scenario 4		Beach Area D	Soils North of I-10	--	--
Post-TCRA	Scenario 1		Beach Area A	Soils North of I-10 $_{POST\text{-}TCRA}$	--	--
South Impoundment						
Trespasser						
Pre- and Post-TCRA	Scenario 1		--	Soils South of I-10	--	--
Worker						
Pre- and Post-TCRA	Scenario 1		--	Soils South of I-10	--	--

Notes

-- = Not applicable, exposure pathway not potentially complete per CSM and more refined conceptualization of the Site presented in Section 4 of the text.
BHHRA = baseline human health risk assessment
CSM = conceptual site model
EU = exposure unit
FCA = fish collection area
TCRA = time critical removal action

a - Post-TCRA scenarios assume that access to the Site continues to be restricted by fencing. Fence lines are displayed in Figures 4, 8, and 11.
b - Complete descriptions of the EUs are shown in Table 6.

Table 8
Exposure Assumptions for the North Impoundment Recreational Fisher

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Recreational Fisher
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of fish and shellfish, Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	RME	CTE	Rationale/Reference	Exposure Equations [a]
Ingestion of Fish and Shellfish							
$COPC_H$ Terms, All Age Groups	$COPC_H$ concentration in fish	C_{fish}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			I_{fish}(mg/kg-day) = C_{fish} x (1-LOSS) x IR_{fish} x RBA_{food} x $FI_{fish,shellfish}$ x $EF_{fish,\ shellfish}$ x ED x CF/(BW x AT)
	$COPC_H$ concentration in shellfish	$C_{shellfish}$	mg/kg	Chemical-specific, see Section 3.5 on EPCs			
	Chemical reduction due to preparation and cooking	LOSS	% as fraction	Chemical-specific, see Table 15			
	Relative food bioavailability adjustment	RBA_{food}	% as fraction	Chemical-specific, see Table 15			$I_{shellfish}$(mg/kg-day) = $C_{shellfish}$ x (1-LOSS) x $IR_{shellfish}$ x RBA_{food} x $FI_{fish,shellfish}$ x $EF_{fish,\ shellfish}$ x ED x CF/(BW x AT)
Adult	Ingestion rate, fish	IR_{fish}	g/day	24	21	Alcoa (1998), study of Lavaca Bay. Based on 95UCL (RME) and arithmetic average (CTE) rates. Rates are averages for men and women combined.	
	Ingestion rate, shellfish	$IR_{shellfsh}$	g/day	1.4	1.0	Alcoa (1998), study of Lavaca Bay. Based on 95UCL (RME) and arithmetic average (CTE) rates. Rates are averages for men and women combined.	where: CF= 1E-03 kg/g
	Fraction of total fish or shellfish intake that is site-related	$FI_{fish,shellfish}$	% as fraction	0.25	0.10	Site-specific; based on conservative interpretation from Alcoa (1998) study of Lavaca Bay.	
	Exposure frequency, fish, shellfish	$EF_{fish,shellfish}$	days/year	365	365	Fish and shellfish ingestion rates are annualized daily averages.	
	Exposure duration	ED	years	16	12	USEPA (2011b). RME assumes summation with older child and young child age groups for a total of 33 years; CTE assumes 12 years as an adult.	
	Body weight	BW	kg	80	80	USEPA (2011b)	
	Averaging time - non-carcinogens	ATn	days	5,840	4,380	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Older Child (Age 7 to <18)	Ingestion rate, fish	IR_{fish}	g/day	18	--	Alcoa (1998), study of Lavaca Bay. Based on 95UCL rate for youths.	
	Ingestion rate, shellfish	$IR_{shellfsh}$	g/day	1.0	--	Alcoa (1998), study of Lavaca Bay. Based on 95UCL rate for youths.	
	Fraction of total fish or shellfish intake that is site-related	$FI_{fish,shellfish}$	% as fraction	0.25	--	Site-specific; based on conservative interpretation from Alcoa (1998) study of Lavaca Bay.	
	Exposure frequency, fish, shellfish	$EF_{fish,shellfish}$	days/year	365	--	Fish and shellfish ingestion rates are annualized averages.	
	Exposure duration	ED	years	11	--	USEPA (2011b). RME assumes summation with adult and young child age groups for a total of 33 years.	
	Body weight	BW	kg	50	--	USEPA (2011b). Average for 7 to <18 year age group.	
	Averaging time - non-carcinogens	ATn	days	4,015	--	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	--	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Young Child (Age 1 to <7)	Ingestion rate, fish	IR_{fish}	g/day	14	--	Alcoa (1998), study of Lavaca Bay. Based on 95UCL rate for small children.	
	Ingestion rate, shellfish	$IR_{shellfsh}$	g/day	0.6	--	Alcoa (1998), study of Lavaca Bay. Based on 95UCL rate for small children.	
	Fraction of total fish or shellfish intake that is site-related	$FI_{fish,shellfish}$	% as fraction	0.25	--	Site-specific; based on conservative interpretation from Alcoa (1998) study of Lavaca Bay.	
	Exposure frequency, fish, shellfish	$EF_{fish,shellfish}$	days/year	365	--	Fish and shellfish ingestion rates are annualized averages.	
	Exposure duration	ED	years	6	--	USEPA (2011b). RME assumes summation with adult and young child age groups for a total of 33 years.	
	Body weight	BW	kg	19	--	USEPA (2011b). Average for 1 to <7 year age group.	
	Averaging time - non-carcinogens	ATn	days	2,190	--	USEPA (1989); ED x 365 days/year	

Table 8
Exposure Assumptions for the North Impoundment Recreational Fisher

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Recreational Fisher
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of fish and shellfish, Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	RME	CTE	Rationale/Reference	Exposure Equations [a]
	Averaging time - carcinogens	ATc	days	28,470	--	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Ingestion of Soil and Sediment							
$COPC_H$ Terms, All Age Groups	$COPC_H$ concentration in soil	C_{soil}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			$I_{soil\text{-}sed}$ (mg/kg-day) = $[(C_{soil} \times IR_{soil} \times F_{soil}) + (C_{sed} \times IR_{sed} \times F_{sed})] \times RBA_{ss} \times FI_{soil\text{-}sed} \times EF_{soil\text{-}sed} \times ED \times CF / (BW \times AT)$
	$COPC_H$ concentration in sediment	C_{sed}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			
	Relative soil / sediment bioavailability adjustment	RBA_{ss}	% as fraction	Chemical-specific, see Table 15			
Adult	Ingestion rate, soil	IR_{soil}	mg/day	20	20	USEPA (2011b)	
	Ingestion rate, sediment	IR_{sed}	mg/day	20	20	USEPA (2011b). Based on ingestion rates for soil.	where: CF= 1E-06 kg/mg
	Fraction of total ingestion that is soil	F_{soil}	% as fraction	0	0	Assumes soil exposure for the fisher is negligible compared to sediment exposure.	
	Fraction of total ingestion that is sediment	F_{sed}	% as fraction	1	1	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	0.5	BPJ	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	39	13	USFWS (2008); average trips per year for Texas residents fishing marine waters (CTE); professional judgment (RME) (see text).	
	Exposure duration	ED	years	16	12	USEPA (2011b). RME assumes summation with older child and young child age groups for a total of 33 years; CTE assumes 12 years as an adult.	
	Body weight	BW	kg	80	80	USEPA (2011b)	
	Averaging time - non-carcinogens	ATn	days	5,840	4,380	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Older Child (Age 7 to <18)	Ingestion rate, soil	IR_{soil}	mg/day	50	--	USEPA (2011b)	
	Ingestion rate, sediment	IR_{sed}	mg/day	50	--	USEPA (2011b); based on ingestion rates for soil.	
	Fraction of total ingestion that is soil	F_{soil}	% as fraction	0	--	Assumes soil exposure for the fisher is negligible compared to sediment exposure.	
	Fraction of total ingestion that is sediment	F_{sed}	% as fraction	1	--	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	--	BPJ	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	39	--	Professional judgment; based on average trips per year for Texas residents fishing marine waters (see text).	
	Exposure duration	ED	years	11	--	USEPA (2011b). RME assumes summation with adult and young child age groups for a total of 33 years.	
	Body weight	BW	kg	50	--	USEPA (2011b). Average for 7 to <18 year age group.	
	Averaging time - non-carcinogens	ATn	days	4,015	--	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	--	USEPA (1989, 2011b); based on life expectancy of 78 years	
Young Child (Age 1 to <7)	Ingestion rate, soil	IR_{soil}	mg/day	125	--	USEPA (2011b); weighted average of recommended rates of 50 mg/day for 1,2, and 6 year olds and of 200 mg/day for 3 to 5 year olds.	

Table 8
Exposure Assumptions for the North Impoundment Recreational Fisher

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Recreational Fisher
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of fish and shellfish, Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	RME	CTE	Rationale/Reference	Exposure Equations [a]
	Ingestion rate, sediment	IR_{sed}	mg/day	125	--	USEPA (2011b); based on ingestion rates for soil, weighted average of recommended rates of 50 mg/day for 1,2, and 6 year olds and of 200 mg/day for 3 to 5 year olds.	
	Fraction of total ingestion that is soil	F_{soil}	% as fraction	0	--	Assumes soil exposure for the fisher is negligible compared to sediment exposure.	
	Fraction of total ingestion that is sediment	F_{sed}	% as fraction	1	--	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	--	BPJ	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	39	--	Professional judgment; based on average trips per year for Texas residents fishing marine waters (see text).	
	Exposure duration	ED	years	6	--	USEPA (2011b). RME assumes summation with adult and older child age groups for a total of 33 years.	
	Body weight	BW	kg	19	--	USEPA (2011b). Average for 1 to <7 year age group	
	Averaging time - non-carcinogens	ATn	days	2,190	--	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	--	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Dermal Contact with Soil and Sediment							
$COPC_H$ Terms, All Age Groups	$COPC_H$ concentration in soil	C_{soil}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			$DAD_{soil\text{-}sed}$(mg/kg-day) = DA_{event} x SA x $EF_{soil\text{-}sed}$ x $FI_{soil\text{-}sed}$ x ED x EV/ (BW x AT)
	$COPC_H$ concentration in sediment	C_{sed}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			
	Dermal absorption factor for soil/sediment	ABS_d	% as fraction	Chemical-specific, see Table 15			where:
Adult	Skin surface area	SA	cm^2	6,080	6,080	USEPA (2004, 2011b). Assumes forearms, hands, lower legs, and feet.	$DA_{event}(mg/cm^2) = [(C_{soil}$ x AF_{soil}x F_{soil}) +(C_{sed}x AF_{sed}x F_{sed})] x ABS_d x CF
	Adherence factor, soil	AF_{soil}	mg/cm^2	0.07	0.07	USEPA (2011b); values are based on studies of adults exposed to soil by way of various activities; weighted average of adherence factors for exposed body parts.	
	Adherence factor, sediment	AF_{sed}	mg/cm^2	4.9	4.9	USEPA (2011b); values are based on study of children playing in sediment; weighted average of adherence factors for exposed body parts.	where: CF= 1E-06 kg/mg
	Fraction of pathway exposure to soil	F_{soil}	% as fraction	0	0	Assumes soil exposure for the fisher is negligible compared to sediment exposure.	
	Fraction of pathway exposure to sediment	F_{sed}	% as fraction	1	1	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	0.5	BPJ	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	39	13	USFWS (2008); rate for Texas residents fishing marine waters (CTE); BPJ (RME)	
	Exposure duration	ED	years	16	12	USEPA (2011b). RME assumes summation with older child and young child age groups for a total of 33 years; CTE assumes 12 years as an adult.	
	Event frequency	EV	1/day	1	1	USEPA (2004)	

Table 8
Exposure Assumptions for the North Impoundment Recreational Fisher

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Recreational Fisher
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of fish and shellfish, Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	RME	CTE	Rationale/Reference	Exposure Equations [a]
	Body weight	BW	kg	80	80	USEPA (2011b)	
	Averaging time - non-carcinogens	ATn	days	5,840	4,380	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Older Child (Age 7 to <18)	Skin surface area	SA	cm^2	4,270	--	USEPA (2004, 2011b); assumes forearms, hands, lower legs, and feet.	
	Adherence factor, soil	AF_{soil}	mg/cm^2	0.07	--	USEPA (2011b); values are based on studies of adults exposed to soil by way of various activities; weighted average of adherence factors for exposed body parts.	
	Adherence factor, sediment	AF_{sed}	mg/cm^2	5.1	--	USEPA (2011b); values are based on study of children playing in sediment; weighted average of adherence factors for exposed body parts.	
	Fraction of pathway exposure to soil	F_{soil}	% as fraction	0	--	Assumes soil exposure for the fisher is negligible compared to sediment exposure.	
	Fraction of pathway exposure to sediment	F_{sed}	% as fraction	1	--	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	--	BPJ	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	39	--	BPJ based on USFWS (2008) mean rate for Texas residents fishing marine waters of 13 days per year.	
	Exposure duration	ED	years	11	--	USEPA (2011b). RME assumes summation with adult and young child age groups for a total of 33 years	
	Event frequency	EV	1/day	1	--	USEPA (2004)	
	Body weight	BW	kg	50	--	USEPA (2011b). Average for 7 to <18 year age group	
	Averaging time - non-carcinogens	ATn	days	4,015	--	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	--	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Young Child (Age 1 to <7)	Skin surface area	SA	cm^2	3,280	--	USEPA (2004, 2011b); assumes forearms, hands, lower and upper legs, and feet.	
	Adherence factor, soil	AF_{soil}	mg/cm^2	0.09	--	USEPA (2011b); values are based on study of children exposed to soil; weighted average of adherence factors for exposed body parts.	
	Adherence factor, sediment	AF_{sed}	mg/cm^2	3.6	--	USEPA (2011b); values are based on study of children playing in sediment; weighted average of adherence factors for exposed body parts.	
	Fraction of pathway exposure to soil	F_{soil}	% as fraction	0	--	Assumes soil exposure for the fisher is negligible compared to sediment exposure	
	Fraction of pathway exposure to sediment	F_{sed}	% as fraction	1	--	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	--	BPJ	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	39	--	BPJ based USFWS (2008) mean rate for Texas residents fishing marine waters of 13 days per year.	

Table 8
Exposure Assumptions for the North Impoundment Recreational Fisher

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Recreational Fisher
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of fish and shellfish, Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	RME	CTE	Rationale/Reference	Exposure Equations [a]
	Exposure duration	ED	years	6	--	USEPA (2011b). RME assumes summation with adult and older child age groups for a total of 33 years.	
	Event frequency	EV	1/day	1	--	USEPA (2004)	
	Body weight	BW	kg	19	--	USEPA (2011b). Average for 1 to <7 year age group.	
	Averaging time - non-carcinogens	ATn	days	2,190	--	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	--	USEPA (1989, 2011b); based on life expectancy of 78 years.	

Notes

-- = not applicable
ADD = average daily dose
BPJ = best profesional judgment
$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessment
CTE = central tendency exposure
DAD = dermally absorbed dose
I = intake (daily)
LADD = lifetime average daily dose
RME = reasonable maximum exposure

a - LADD will be calculated as the sum of I or DAD across all age groups for whom exposure is assumed to occur. ADD will be assumed as the I or DAD from the age group with the highest intake

Table 9
Exposure Assumptions for the North Impoundment Subsistence Fisher

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Subsistence Fisher
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of fish and shellfish, Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	Value	Rationale/Reference	Exposure Equations [a]
Ingestion of Fish & Shellfish						
$COPC_H$ Terms, All Age Groups	$COPC_H$ concentration in fish	C_{fish}	mg/kg	Chemical-specific, see Section 3.5 on EPCs		I_{fish}(mg/kg-day) = C_{fish} x (1-LOSS) x IR_{fish} x RBA_{food} x $FI_{fish,shellfish}$ x $EF_{fish, shellfish}$ x ED x CF/(BW x AT) $I_{shellfish}$(mg/kg-day) = $C_{shellfish}$ x (1-LOSS) x $IR_{shellfish}$ x RBA_{food} x $FI_{fish,shellfish}$ x $EF_{fish, shellfish}$ x ED x CF/(BW x AT) where: CF= 1E-03 kg/g
	$COPC_H$ concentration in shellfish	$C_{shellfish}$	mg/kg	Chemical-specific, see Section 3.5 on EPCs		
	Chemical reduction due to preparation and cooking	LOSS	% as fraction	Chemical-specific, see Table 15		
	Relative Food Bioavailability Adjustment	RBA_{food}	% as fraction	Chemical-specific, see Table 15		
Adult	Ingestion rate, fish	IR_{fish}	g/day	58	Alcoa (1998), study of Lavaca Bay. Based on ranked 90th percentile of distribution. Rates are averages for men and women.	
	Ingestion rate, shellfish	$IR_{shellfsh}$	g/day	3.8	Alcoa (1998), study of Lavaca Bay. Based on ranked 95th percentile of distribution. Rates are averages for men and women.	
	Fraction of total fish or shellfish intake that is site-related	$FI_{fish,shellfish}$	% as fraction	1	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency, fish, shellfish	$EF_{fish,shellfish}$	days/year	365	Fish and shellfish ingestion rates are annualized averages.	
	Exposure duration	ED	years	16	USEPA (2011b). Assumes summation with older child and young child age groups for a total of 33 years.	
	Body weight	BW	kg	80	USEPA (2011b)	
	Averaging time - non-carcinogens	ATn	days	5,840	USEPA (1989); ED * 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Older Child (Age 7 to <18)	Ingestion rate, fish	IR_{fish}	g/day	45	Alcoa (1998), study of Lavaca Bay. Based on ranked 90th percentile of distribution for youths.	
	Ingestion rate, shellfish	$IR_{shellfsh}$	g/day	4.5	Alcoa (1998), study of Lavaca Bay. Based on ranked 95th percentile of distribution for youths.	
	Fraction of total fish or shellfish intake that is site-related	$FI_{fish,shellfish}$	% as fraction	1	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency, fish, shellfish	$EF_{fish,shellfish}$	days/year	365	Fish and shellfish ingestion rates are annualized averages.	
	Exposure duration	ED	years	11	USEPA (2011b). Assumes summation with adult and young child age groups for a total of 33 years.	
	Body weight	BW	kg	50	USEPA (2011b). Average for 7 to <18 year age group	
	Averaging time - non-carcinogens	ATn	days	4,015	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Young Child (Age 1 to <7)	Ingestion rate, fish	IR_{fish}	g/day	30	Alcoa (1998), study of Lavaca Bay. Based on ranked 90th percentile of distribution for young children.	
	Ingestion rate, shellfish	$IR_{shellfsh}$	g/day	2.0	Alcoa (1998), study of Lavaca Bay. Based on ranked 95th percentile of distribution for young children.	
	Fraction of total fish or shellfish intake that is site-related	$FI_{fish,shellfish}$	% as fraction	1	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency, fish, shellfish	$EF_{fish,shellfish}$	days/year	365	Fish and shellfish ingestion rates are annualized averages.	
	Exposure duration	ED	years	6	USEPA (2011b). Assumes summation with adult and young child age groups for a total of 33 years.	
	Body weight	BW	kg	19	USEPA (2011b). Average for 1 to <7 year age group.	
	Averaging time - non-carcinogens	ATn	days	2,190	USEPA (1989); ED x 365 days/year	

Table 9
Exposure Assumptions for the North Impoundment Subsistence Fisher

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Subsistence Fisher
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of fish and shellfish, Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	Value	Rationale/Reference	Exposure Equations [a]
	Averaging time - carcinogens	ATc	days	28,470	USEPA (1989), USEPA (2011b); based on life expectancy of 78 years.	
Ingestion of Soil and Sediment						
$COPC_H$ Terms, All Age Groups	$COPC_H$ concentration in soil	C_{soil}	mg/kg	Chemical-specific, see Section 3.5 on EPCs		$I_{soil\text{-}sed}$ (mg/kg-day) = ([C_{soil} x IR_{soil} x F_{soil}] + [C_{sed} x IR_{sed} x F_{sed}]) x RBA_{ss} x $FI_{soil\text{-}sed}$ x $EF_{soil\text{-}sed}$ x ED x CF/(BW x AT)
	$COPC_H$ concentration in sediment	C_{sed}	mg/kg	Chemical-specific, see Section 3.5 on EPCs		
	Relative Soil / Sediment Bioavailability Adjustment	RBA_{ss}	% as fraction	Chemical-specific, see Table 15		
Adult	Ingestion rate, soil	IR_{soil}	mg/day	20	USEPA (2011b)	where: CF= 1E-06 kg/mg
	Ingestion rate, sediment	IR_{sed}	mg/day	20	USEPA (2011b). Based on ingestion rates for soil.	
	Fraction of total ingestion that is soil	F_{soil}	% as fraction	0	Assumes soil exposure for the fisher is negligible compared to sediment exposure.	
	Fraction of total ingestion that is sediment	F_{sed}	% as fraction	1	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	104	BPJ. Assumes average exposure of 2 days per week throughout the year, 52 weeks per year.	
	Exposure duration	ED	years	16	USEPA (2011b). Assumes summation with older child and young child age groups for a total of 33 years.	
	Body weight	BW	kg	80	USEPA (2011b)	
	Averaging time - non-carcinogens	ATn	days	5,840	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	USEPA (1989), USEPA (2011b); based on life expectancy of 78 years.	
Older Child (Age 7 to <18)	Ingestion rate, soil	IR_{soil}	mg/day	50	USEPA (2011b)	
	Ingestion rate, sediment	IR_{sed}	mg/day	50	USEPA (2011b); based on ingestion rates for soil.	
	Fraction of total ingestion that is soil	F_{soil}	% as fraction	0	Assumes soil exposure for the fisher is negligible compared to sediment exposure.	
	Fraction of total ingestion that is sediment	F_{sed}	% as fraction	1	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	104	BPJ. Assumes average exposure of 2 days per week throughout the year, 52 weeks per year.	
	Exposure duration	ED	years	11	USEPA (2011b). Assumes summation with adult and young child age groups for a total of 33 years.	
	Body weight	BW	kg	50	USEPA (2011b). Average for 7 to <18 year age group.	
	Averaging time - non-carcinogens	ATn	days	4,015	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Young Child (Age 1 to <7)	Ingestion rate, soil	IR_{soil}	mg/day	125	USEPA (2011b); weighted average of recommended rates of 50 mg/day for 1,2, and 6 year olds and of 200 mg/day for 3 to 5 year olds.	
	Ingestion rate, sediment	IR_{sed}	mg/day	125	USEPA (2011b); based on ingestion rates for soil, weighted average of recommended rates of 50 mg/day for 1,2, and 6 year olds and of 200 mg/day for 3 to 5 year olds.	
	Fraction of total ingestion that is soil	F_{soil}	% as fraction	0	Assumes soil exposure for the fisher is negligible compared to sediment exposure.	

Table 9
Exposure Assumptions for the North Impoundment Subsistence Fisher

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Subsistence Fisher
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of fish and shellfish, Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	Value	Rationale/Reference	Exposure Equations [a]
	Fraction of total ingestion that is sediment	F_{sed}	% as fraction	1	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	104	BPJ. Assumes average exposure of 2 days per week throughout the year, 52 weeks per year.	
	Exposure duration	ED	years	6	USEPA (2011b). Assumes summation with adult and older child age groups for a total of 33 years.	
	Body weight	BW	kg	19	USEPA (2011b). Average for 1 to <7 year age group.	
	Averaging time - non-carcinogens	ATn	days	2,190	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Dermal Contact with Soil and Sediment						
$COPC_H$ Terms, All Age Groups	$COPC_H$ concentration in soil	C_{soil}	mg/kg		Chemical-specific, see Section 3.5 on EPCs	$DAD_{soil\text{-}sed}$ (mg/kg-day) = DA_{event} x SA x $EF_{soil\text{-}sed}$ x $FI_{soil\text{-}sed}$ x ED x EV/(BW x AT) where: DA_{event}(mg/cm^2) = [(C_{soil} x AF_{soil} x F_{soil})+(C_{sed} x AF_{sed} x F_{sed})] x ABS_d x CF where: CF= 1E-06 kg/mg
	$COPC_H$ concentration in sediment	C_{sed}	mg/kg		Chemical-specific, see Section 3.5 on EPCs	
	Dermal absorption factor for soil/sediment	ABS_d	% as fraction		Chemical-specific, see Table 15	
Adult	Skin surface area	SA	cm^2	6,080	USEPA (2004, 2011b). Assumes forearms, hands, lower legs, and feet.	
	Adherence factor, soil	AF_{soil}	mg/cm^2	0.07	USEPA (2011b); values are based on studies of adults exposed to soil by way of various activities; weighted average of adherence factors for exposed body parts.	
	Adherence factor, sediment	AF_{sed}	mg/cm^2	4.9	USEPA (2011b); values are based on study of children playing in sediment; weighted average of adherence factors for exposed body parts.	
	Fraction of pathway exposure to soil	F_{soil}	% as fraction	0	Assumes soil exposure for the fisher is negligible compared to sediment exposure.	
	Fraction of pathway exposure to sediment	F_{sed}	% as fraction	1	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	104	BPJ. Assumes average exposure of 2 days per week throughout the year, 52 weeks per year.	
	Exposure duration	ED	years	16	USEPA (2011b). Assumes summation with older child and young child age groups for a total of 33 years.	
	Event frequency	EV	1/day	1	USEPA (2004)	
	Body weight	BW	kg	80	USEPA (2011b)	
	Averaging time - non-carcinogens	ATn	days	5,840	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Older Child (Age 7 to <18)	Skin surface area	SA	cm^2	4,270	USEPA (2004, 2011b); assumes forearms, hands, lower legs, and feet.	
	Adherence factor, soil	AF_{soil}	mg/cm^2	0.07	USEPA (2011b); values are based on studies of adults exposed to soil by way of various activities; weighted average of adherence factors for exposed body parts.	
	Adherence factor, sediment	AF_{sed}	mg/cm^2	5.1	USEPA (2011b); values are based on study of children playing in sediment; weighted average of adherence factors for exposed body parts.	
	Fraction of pathway exposure to soil	F_{soil}	% as fraction	0	Assumes soil exposure for the fisher is negligible compared to sediment exposure.	

Table 9
Exposure Assumptions for the North Impoundment Subsistence Fisher

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Subsistence Fisher
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of fish and shellfish, Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	Value	Rationale/Reference	Exposure Equations [a]
	Fraction of pathway exposure to sediment	F_{sed}	% as fraction	1	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	104	BPJ. Assumes average exposure of 2 days per week throughout the year, 52 weeks per year.	
	Exposure duration	ED	years	11	USEPA (2011b). Assumes summation with adult and young child age groups for a total of 33 years.	
	Event frequency	EV	1/day	1	USEPA (2004)	
	Body weight	BW	kg	50	USEPA (2011b). Average for 7 to <18 year age group.	
	Averaging time - non-carcinogens	ATn	days	4,015	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Young Child (Age 1 to <7)	Skin surface area	SA	cm^2	3,280	USEPA (2004, 2011b); assumes forearms, hands, lower and upper legs, and feet.	
	Adherence factor, soil	AF_{soil}	mg/cm^2	0.09	USEPA (2011b); values are based on study of children exposed to soil; weighted average of adherence factors for exposed body parts.	
	Adherence factor, sediment	AF_{sed}	mg/cm^2	3.6	USEPA (2011b); values are based on study of children playing in sediment; weighted average of adherence factors for exposed body parts.	
	Fraction of pathway exposure to soil	F_{soil}	% as fraction	0	Assumes soil exposure for the fisher is negligible compared to sediment exposure.	
	Fraction of pathway exposure to sediment	F_{sed}	% as fraction	1	Assumes fisher is primarily exposed to sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	104	BPJ. Assumes average exposure of 2 days per week throughout the year, 52 weeks per year.	
	Exposure duration	ED	years	6	USEPA (2011b). Assumes summation with adult and older child age groups for a total of 33 years.	
	Event frequency	EV	1/day	1	USEPA (2004)	
	Body weight	BW	kg	19	USEPA (2011b). Average for 1 to <7 year age group.	
	Averaging time - non-carcinogens	ATn	days	2,190	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	

Notes

ADD = average daily dose
BPJ = best professional judgment
$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessment
DAD = dermally absorbed dose
I = intake (daily)
LADD = lifetime average daily dose

a - LADD will be calculated as the sum of I or DAD across all age groups for whom exposure is assumed to occur. ADD will be assumed as the I or DAD from the age group with the highest intake.

Table 10
Exposure Assumptions for the North Impoundment Recreational Visitor

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Recreational Visitor
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	RME	CTE	Rationale/Reference	Exposure Equations [a]
Ingestion of Soil and Sediment							
$COPC_H$ Terms, All Age Groups	$COPC_H$ concentration in soil	C_{soil}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			$I_{soil\text{-}sed}$ (mg/kg-day)= ([C_{soil} x IR_{soil} x F_{soil}] + [C_{sed} x IR_{sed} x F_{sed}]) x RBA_{ss} x $FI_{soil\text{-}sed}$ x $EF_{soil\text{-}sed}$ x ED x CF/ (BW x AT) where: CF = 1E-06 kg/mg
	$COPC_H$ concentration in sediment	C_{sed}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			
	Relative soil / sediment bioavailability adjustment	RBA_{ss}	% as fraction	Chemical-specific, see Table 15			
Adult	Ingestion rate, soil	IR_{soil}	mg/day	20	20	USEPA (2011b)	
	Ingestion rate, sediment	IR_{sed}	mg/day	20	20	USEPA (2011b); based on ingestion rates for soil.	
	Fraction of total ingestion that is soil	F_{soil}	% as fraction	0.5	0.5	Assumes half of visitor's direct exposure is with soil.	
	Fraction of total ingestion that is sediment	F_{sed}	% as fraction	0.5	0.5	Assumes half of visitor's direct exposure is with sediment.	
	Fraction of total daily intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	0.5	Site-specific; based on BPJ.	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	104	52	BPJ. Assumes average exposure of 2 days per week (RME) and 1 day per week (CTE) throughout the year, 52 weeks per year.	
	Exposure duration	ED	years	16	12	USEPA (2011b). RME assumes summation with older child and young child age groups for a total of 33 years; CTE assumes 12 years as an adult.	
	Body weight	BW	kg	80	80	USEPA (2011b)	
	Averaging time - non-carcinogens	ATn	days	5,840	4,380	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Older Child (Age 7 to <18)	Ingestion rate, soil	IR_{soil}	mg/day	50	--	USEPA (2011b)	
	Ingestion rate, sediment	IR_{sed}	mg/day	50	--	USEPA (2011b); based on ingestion rates for soil.	
	Fraction of total ingestion that is soil	F_{soil}	% as fraction	0.5	--	Assumes half of visitor's direct exposure is with soil.	
	Fraction of total ingestion that is sediment	F_{sed}	% as fraction	0.5	--	Assumes half of visitor's direct exposure is with sediment.	
	Fraction of total daily intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	--	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	104	--	BPJ. Assumes average exposure of 2 days per week throughout the year, 52 weeks per year.	
	Exposure duration	ED	years	11	--	USEPA (2011b). RME assumes summation with adult and young child age groups for a total of 33 years.	
	Body weight	BW	kg	50	--	USEPA (2011b); average for 7- to <18-year age group.	
	Averaging time - non-carcinogens	ATn	days	4,015	--	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	--	USEPA (1989. 2011b); based on life expectancy of 78 years.	

Table 10
Exposure Assumptions for the North Impoundment Recreational Visitor

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Recreational Visitor
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	RME	CTE	Rationale/Reference	Exposure Equations [a]
Young Child (Age 1 to <7)	Ingestion rate, soil	IR_{soil}	mg/day	125	--	USEPA (2011b); weighted average of recommended rates of 50 mg/day for 1,2, and 6 year olds and of 200 mg/day for 3 to 5 year olds.	
	Ingestion rate, sediment	IR_{sed}	mg/day	125	--	USEPA (2011b); based on ingestion rates for soil, weighted average of recommended rates of 50 mg/day for 1,2, and 6 year olds and of 200 mg/day for 3 to 5 year olds.	
	Fraction of total ingestion that is soil	F_{soil}	% as fraction	0.5	--	Assumes half of visitor's direct exposure is with soil.	
	Fraction of total ingestion that is sediment	F_{sed}	% as fraction	0.5	--	Assumes half of visitor's direct exposure is with sediment.	
	Fraction of total daily intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	--	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	104	--	BPJ. Assumes average exposure of 2 days per week throughout the year, 52 weeks per year.	
	Exposure duration	ED	years	6	--	USEPA (2011b). RME assumes summation with adult and older child age groups for a total of 33 years.	
	Body weight	BW	kg	19	--	USEPA (2011b); average for 1- to <7-year age group.	
	Averaging time - non-carcinogens	ATn	days	2,190	--	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	--	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Dermal Contact with Soil and Sediment							
$COPC_H$ Terms, All Age Groups	$COPC_H$ concentration in soil	C_{soil}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			$DAD_{soil\text{-}sed}$ (mg/kg-day) = DA_{event} x SA x $EF_{soil\text{-}sed}$ x ED x $FI_{soil\text{-}sed}$ x EV/ (BW x AT) where: DA_{event} (mg/cm^2) = (C_{soil} x AF_{soil} x F_{soil})+(C_{sed} x AF_{sed} x F_{sed})x ABS_d x CF where: CF= 1E-06 kg/mg
	$COPC_H$ concentration in sediment	C_{sed}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			
	Dermal Absorption Factor for Soil/Sediment	ABS_d	% as fraction	Chemical-specific, see Table 15			
Adult	Skin surface area	SA	cm^2	6,080	6,080	USEPA (2004, 2011b). Assumes forearms, hands, lower legs, and feet.	
	Adherence factor, soil	AF_{soil}	mg/cm^2	0.07	0.07	USEPA (2011b): values are based on studies of adults exposed to soil by way of various activities; weighted average of adherence factors for exposed body parts.	
	Adherence factor, sediment	AF_{sed}	mg/cm^2	4.9	4.9	USEPA (2011b); values are based on study of children playing in sediment; weighted average of adherence factors for exposed body parts.	
	Fraction of pathway exposure to soil	F_{soil}	% as fraction	0.5	0.5	Assumes half of visitor's direct exposure is with soil.	
	Fraction of pathway exposure to sediment	F_{sed}	% as fraction	0.5	0.5	Assumes half of visitor's direct exposure is with sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil\text{-}sed}$	% as fraction	1	0.5	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	104	52	BPJ. Assumes average exposure of 2 days per week (RME) and 1 day per week (CTE) throughout the year, 52 weeks per year.	

Table 10
Exposure Assumptions for the North Impoundment Recreational Visitor

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Recreational Visitor
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	RME	CTE	Rationale/Reference	Exposure Equations [a]
	Exposure duration	ED	years	16	12	USEPA (2011b). RME assumes summation with older child and young child age groups for a total of 33 years; CTE assumes 12 years as an adult.	
	Event frequency	EV	1/day	1	1	USEPA (2004)	
	Body weight	BW	kg	80	80	USEPA (2011b)	
	Averaging time - non-carcinogens	ATn	days	5,840	4,380	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Older Child (Age 7 to <18)	Skin surface area	SA	cm^2	4,270	--	USEPA (2004, 2011b); assumes forearms, hands, lower legs, and feet.	
	Adherence factor, soil	AF_{soil}	mg/cm^2	0.07	--	USEPA (2011b): values are based on studies of adults exposed to soil by way of various activities; weighted average of adherence factors for exposed body parts.	
	Adherence factor, sediment	AF_{sed}	mg/cm^2	5.1	--	USEPA (2011b); values are based on study of children playing in sediment; weighted average of adherence factors for exposed body parts.	
	Fraction of pathway exposure to soil	F_{soil}	% as fraction	0.5	--	Assumes half of visitor's direct exposure is with soil.	
	Fraction of pathway exposure to sediment	F_{sed}	% as fraction	0.5	--	Assumes half of visitor's direct exposure is with sediment.	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil-sed}$	% as fraction	1	--	Site-specific; conservative assumption based on BPJ.	
	Exposure frequency; soil, sediment	$EF_{soil-sed}$	days/year	104	--	BPJ. Assumes average exposure of 2 days per week throughout the year, 52 weeks per year.	
	Exposure duration	ED	years	11	--	USEPA (2011b). RME assumes summation with adult and young child age groups for a total of 33 years.	
	Event frequency	EV	1/day	1	--	USEPA (2004)	
	Body weight	BW	kg	50	--	USEPA (2011b). Average for 7 to <18 year age group.	
	Averaging time - non-carcinogens	ATn	days	4,015	--	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	--	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Young Child (Age 1 to <7)	Skin surface area	SA	cm^2	3,280	--	USEPA (2004, 2011b); assumes forearms, hands, lower and upper legs, and feet.	
	Adherence factor, soil	AF_{soil}	mg/cm^2	0.09	--	USEPA (2011b): values are based on study of children exposed to soil; weighted average of adherence factors for exposed body parts.	
	Adherence factor, sediment	AF_{sed}	mg/cm^2	3.6	--	USEPA (2011b); values are based on study of children playing in sediment; weighted average of adherence factors for exposed body parts.	
	Fraction of pathway exposure to soil	F_{soil}	% as fraction	0.5	--	Assumes half of visitor's direct exposure is with soil.	
	Fraction of pathway exposure to sediment	F_{sed}	% as fraction	0.5	--	Assumes half of visitor's direct exposure is with sediment	
	Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil-sed}$	% as fraction	1	--	Site-specific; based on conservative interpretation from Alcoa (1998) study of Lavaca Bay .	

Table 10
Exposure Assumptions for the North Impoundment Recreational Visitor

CSM Area: North Impoundment Area and Aquatic Environment
Receptor: Recreational Visitor
Applicable Scenarios: Pre-TCRA, Post-TCRA
Exposure Pathways: Ingestion of sediment/soils, Dermal absorption of sediment/soils

Exposure Pathway and Receptor	Term		Units	RME	CTE	Rationale/Reference	Exposure Equations [a]
	Exposure frequency; soil, sediment	$EF_{soil\text{-}sed}$	days/year	104	--	BPJ. Assumes average exposure of 2 days per week throughout the year, 52 weeks per year.	
	Exposure duration	ED	years	6	--	USEPA (2011b). RME assumes summation with adult and older child age groups for a total of 33 years.	
	Event frequency	EV	1/day	1	--	USEPA (2004)	
	Body weight	BW	kg	19	--	USEPA (2011b); average for 1- to <7-year age group.	
	Averaging time - non-carcinogens	ATn	days	2,190	--	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	--	USEPA (1989, 2011b); based on life expectancy of 78 years.	

Notes

-- = not applicable
ADD = average daily dose
BPJ = best professional judgment
$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessment
CTE = central tendency exposure
DAD = dermally absorbed dose
I = Intake (daily)
LADD = lifetime average daily dose
RME = reasonable maximum exposure

a - LADD will be calculated as the sum of I or DAD across all age groups for whom exposure is assumed to occur. ADD will be assumed as the I or DAD from the age group with the highest intake

Table 11
Exposure Assumptions for the South Impoundment Trespasser

CSM Area: South Impoundment Area
Receptor: Trespasser
Applicable Scenarios: Pre-TCRA/Post-TCRA
Exposure Pathways: Ingestion of soil, Dermal absorption of soil

Exposure Pathway and Receptor	Term		Units	RME	CTE	Rationale/Reference	Exposure Equations [a]
Ingestion of Soil							
$COPC_H$ Terms	$COPC_H$ concentration in soil	C_{soil}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			I_{soil}(mg/kg-day)= C_{soil} x IR_{soil} x RBA_{ss} x FI_{soil} x EF_{soil} x ED x CF/ (BW x AT) where: CF= 1E-06 kg/mg
	Relative soil bioavailability adjustment	RBA_{ss}	% as fraction	Chemical-specific, see Table 15			
Trespasser (Age 16 to <23)	Ingestion rate, soil	IR_{soil}	mg/day	41	41	USEPA (2011b); based on ingestion rates for soil, weighted average of recommended rates of 50 mg/day for 16 to <21 year olds and 20 mg/kg for 21 and 22 year olds.	
	Fraction of total daily soil intake that is site-related.	FI_{soil}	% as fraction	0.5	0.25	Site-specific; assumption based on BPJ.	
	Exposure frequency, soil	EF_{soil}	days/year	24	12	BPJ. Assumes average exposure of 2 days per month (RME) and 1 day per month(CTE) throughout the year.	
	Exposure duration	ED	years	7	4	Based on assumed age group; CTE based on BPJ.	
	Body weight	BW	kg	74	74	USEPA (2011b); average for 16 to <23 year age-group.	
	Averaging time - non-carcinogens	ATn	days	2,555	1,460	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Dermal Contact with Soil							
$COPC_H$ Terms	$COPC_H$ concentration in soil	C_{soil}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			DAD_{soil}(mg/kg-day) = DA_{event} x SA x EF_{soil} x ED x FI_{soil} x EV/ (BW x AT) where: DA_{event}(mg/cm^2) = C_{soil} x AF_{soil} x ABS_d x CF where: CF= 1E-06 kg/mg
	Dermal Absorption Factor for Soil	ABS_d	% as fraction	Chemical-specific, see Table 15			
Trespasser (Age 16 to <23)	Skin surface area	SA	cm^2	5,550	5,550	USEPA (2004, 2011b); assumes forearms, hands, lower legs, and feet.	
	Adherence factor, soil	AF_{soil}	mg/cm^2	0.07	0.07	USEPA (2011b); values are based on studies of adults exposed to soil by way of various activities; weighted average of adherence factors for exposed body parts.	
	Fraction of total daily soil intake that is site-related.	FI_{soil}	% as fraction	0.5	0.25	Site-specific; assumption based on BPJ.	
	Exposure frequency, soil	EF_{soil}	days/year	24	12	BPJ. Assumes average exposure of 2 days per month (RME) and 1 day per month(CTE) throughout the year.	
	Exposure duration	ED	years	7	4	Based on assumed age group; CTE based on BPJ.	
	Event frequency	EV	1/day	1	1	USEPA (2004)	
	Body weight	BW	kg	74	74	USEPA (2011b); average for 16- to <23 year age group.	
	Averaging time - non-carcinogens	ATn	days	2,555	1,460	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	

Notes

ADD = average daily dose
BPJ = best professional judgment
$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessment
CTE = central tendency exposure
DAD = dermally absorbed dose
I = intake (daily)
LADD = lifetime average daily dose
RME = reasonable maximum exposure
a - LADD and ADD will be assumed as I or DAD for the single age group presented.

Table 12
Exposure Assumptions for the South Impoundment Worker

CSM Area: South Impoundment Area
Receptor: Worker
Applicable Scenarios: Pre-TCRA/Post-TCRA
Exposure Pathways: Ingestion of soil, Dermal absorption of soil

Exposure Pathway and Receptor	Term		Units	RME	CTE	Rationale/Reference	Exposure Equations [a]
Ingestion of Soil							
$COPC_H$ Terms	$COPC_H$ concentration in soil	C_{soil}	mg/kg	Chemical-specific, see Section 3.5 on EPCs			I_{soil}(mg/kg-day)= C_{soil} x IR_{soil} x RBA_{ss} x FI_{soil} x EF_{soil} x ED x CF/ (BW x AT)
	Relative soil bioavailability adjustment	RBA_{ss}	% as fraction	Chemical-specific, see Table 15			
Adult Worker	Ingestion rate, soil	IR_{soil}	mg/day	100	50	USEPA (2002c); recommended values for outdoor (RME) and indoor (CTE) workers.	where:
	Fraction of total daily soil intake that is site-related.	FI_{soil}	% as fraction	1	1	Site-specific	CF= 1E-06 kg/mg
	Exposure frequency, soil	EF_{soil}	days/year	225	225	USEPA (2002c); recommended value for outdoor worker.	
	Exposure duration	ED	years	25	12	USEPA (2002c) (RME); BPJ (CTE)	
	Body weight	BW	kg	80	80	USEPA (2011b)	
	Averaging time - non-carcinogens	ATn	days	9,125	4,380	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	
Dermal Contact with Soil							
$COPC_H$ Terms	$COPC_H$ concentration in soil	C_{soil}	mg/kg	Chemicalspecific, see Section 3.5 on EPCs			DAD_{soil}(mg/kg-day) = DA_{event} x SA x EF_{soil} x ED x FI_{soil} x EV/ (BW x AT)
	Dermal absorption factor for soil	ABS_d	% as fraction	Chemical-specific, see Table 15			
Adult Worker	Skin surface area	SA	cm^2	3,470	3,470	USEPA (2004, 2011b). Assumes head, forearms, and hands.	
	Adherence factor, soil	AF_{soil}	mg/cm^2	0.2	0.2	USEPA (2004): central tendency weighted adherence factors for exposed body parts based on high-end soil contact activity for commercial/industrial workers.	where: DA_{event}(mg/cm^2) = C_{soil} x AF_{soil} x ABS_d x CF
	Fraction of total daily soil intake that is site-related.	FI_{soil}	% as fraction	1	1	Site-specific; conservative assumption based on BPJ.	where: CF= 1E-06 kg/mg
	Exposure frequency, soil	EF_{soil}	days/year	225	225	USEPA (2002c); recommended value for outdoor worker.	
	Exposure duration	ED	years	25	12	USEPA (2002c) (RME); BPJ (CTE)	
	Event frequency	EV	1/day	1	1	USEPA (2004); central tendency weighted adherence factors for exposed body parts based on high-end soil contact activity for commercial/industrial workers.	
	Body weight	BW	kg	80	80	USEPA (2011b); based on adult	
	Averaging time - non-carcinogens	ATn	days	9,125	4,380	USEPA (1989); ED x 365 days/year	
	Averaging time - carcinogens	ATc	days	28,470	28,470	USEPA (1989, 2011b); based on life expectancy of 78 years.	

Notes
ADD = average daily dose
BPJ = best professional judgment
$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessment
CTE = central tendency exposure
DAD = dermally absorbed dose
I = intake (daily)
LADD = lifetime average daily dose
RME = reasonable maximum exposure

a - LADD and ADD will be assumed as I or DAD for the single age group presented.

Table 13
Summary of Exposure Assumptions for All Receptors, North Impoundment Area

			Recreational Fisher				Subsistence Fisher			Recreational Visitor			
			RME			CTE	RME			RME			CTE
		Units	Adult	Older Child	Young Child	Adult	Adult	Older Child	Young Child	Adult	Older Child	Young Child	Adult
All Pathways													
Body weight	BW	kg	80	50	19	80	80	50	19	80	50	19	80
Exposure duration	ED	years	16	11	6	12	16	11	6	16	11	6	12
Averaging time - non-carcinogens	ATn	days	5,840	4,015	2,190	4,380	5,840	4,015	2,190	5,840	4,015	2,190	4,380
Averaging time - carcinogens	ATc	days	28,470	28,470	28,470	28,470	28,470	28,470	28,470	28,470	28,470	28,470	28,470
Ingestion of Fish and Shellfish													
Exposure frequency, fish, shellfish	$EF_{fish-shellfish}$	days/year	365	365	365	365	365	365	365	--	--	--	--
Ingestion rate, fish	IR_{fish}	g/day	24	18	14	21	58	45	30	--	--	--	--
Ingestion rate, shellfish	$IR_{shellfsh}$	g/day	1.4	1.0	0.6	1.0	3.8	4.5	2.0	--	--	--	--
Fraction of total fish or shellfish intake that is site-related	$FI_{fish-shellfish}$	% as fraction	0.25	0.25	0.25	0.10	1	1	1	--	--	--	--
Ingestion of Soil and Sediment													
Exposure frequency; soil, sediment	$EF_{soil-sed}$	days/year	39	39	39	13	104	104	104	104	104	104	52
Ingestion rate, soil	IR_{soil}	mg/day	20	50	125	20	20	50	125	20	50	125	20
Ingestion rate, sediment	IR_{sed}	mg/day	20	50	125	20	20	50	125	20	50	125	20
Fraction of total ingestion that is soil	F_{soil}	% as fraction	0	0	0	0	0	0	0	0.5	0.5	0.5	0.5
Fraction of total ingestion that is sediment	F_{sed}	% as fraction	1	1	1	1	1	1	1	0.5	0.5	0.5	0.5
Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil-sed}$	% as fraction	1	1	1	0.5	1	1	1	1	1	1	0.5
Dermal Contact with Soil and Sediment													
Exposure frequency; soil, sediment	$EF_{soil-sed}$	days/year	39	39	39	13	104	104	104	104	104	104	52
Skin surface area	SA	cm^2	6,080	4,270	3,280	6,080	6,080	4,270	3,280	6,080	4,270	3,280	6,080
Adherence factor, soil	AF_{soil}	mg/cm^2	0.07	0.07	0.09	0.07	0.07	0.07	0.09	0.07	0.07	0.09	0.07
Adherence factor, sediment	AF_{sed}	mg/cm^2	4.9	5.1	3.6	4.9	4.9	5.1	3.6	4.9	5.1	3.6	4.9
Fraction of pathway exposure that is soil	F_{soil}	% as fraction	0	0	0	0	0	0	0	0.5	0.5	0.5	0.5
Fraction of pathway exposure that is sediment	F_{sed}	% as fraction	1	1	1	1	1	1	1	0.5	0.5	0.5	0.5
Fraction of total daily soil/sediment intake that is site-related.	$FI_{soil-sed}$	% as fraction	1	1	1	0.5	1	1	1	1	1	1	0.5
Event frequency	EV	1/day	1	1	1	1	1	1	1	1	1	1	1

Notes

Chemical-specific parameters, including relative bioavailability, dermal absorption, and reduction due to preparation and cooking factors are shown in Table 15.

-- = Not applicable; pathway is not evaluated for receptor.
CTE = central tendency exposure
RME = reasonable maximum exposure

Table 14
Summary of Exposure Assumptions for All Receptors, South Impoundment Area

			Trespasser		Worker	
		Units	**RME**	**CTE**	**RME**	**CTE**
All Pathways						
Body weight	BW	kg	74	74	80	80
Exposure duration	ED	years	7	4	25	12
Fraction of total daily soil intake that is site-related.	FI_{soil}	% as fraction	0.5	0.25	1	1
Exposure frequency, soil	EF_{soil}	days/year	24	12	225	225
Averaging time - non-carcinogens	ATn	days	2,555	1,460	9,125	4,380
Averaging time - carcinogens	ATc	days	28,470	28,470	28,470	28,470
Ingestion of Soil						
Ingestion rate, soil	IR_{soil}	mg/day	41	41	100	50
Dermal Contact with Soil						
Skin surface area	SA	cm^2	5,550	5,550	3,470	3,470
Adherence factor, soil	AF_{soil}	mg/cm^2	0.07	0.07	0.2	0.2
Event frequency	EV	1/day	1	1	1	1

Notes

Chemical-specific parameters, including relative bioavailability, and dermal absorption factors are shown in Table 15.

CTE = central tendency exposure
RME = reasonable maximum exposure

Table 15
Summary of Chemical-Specific Exposure Parameters

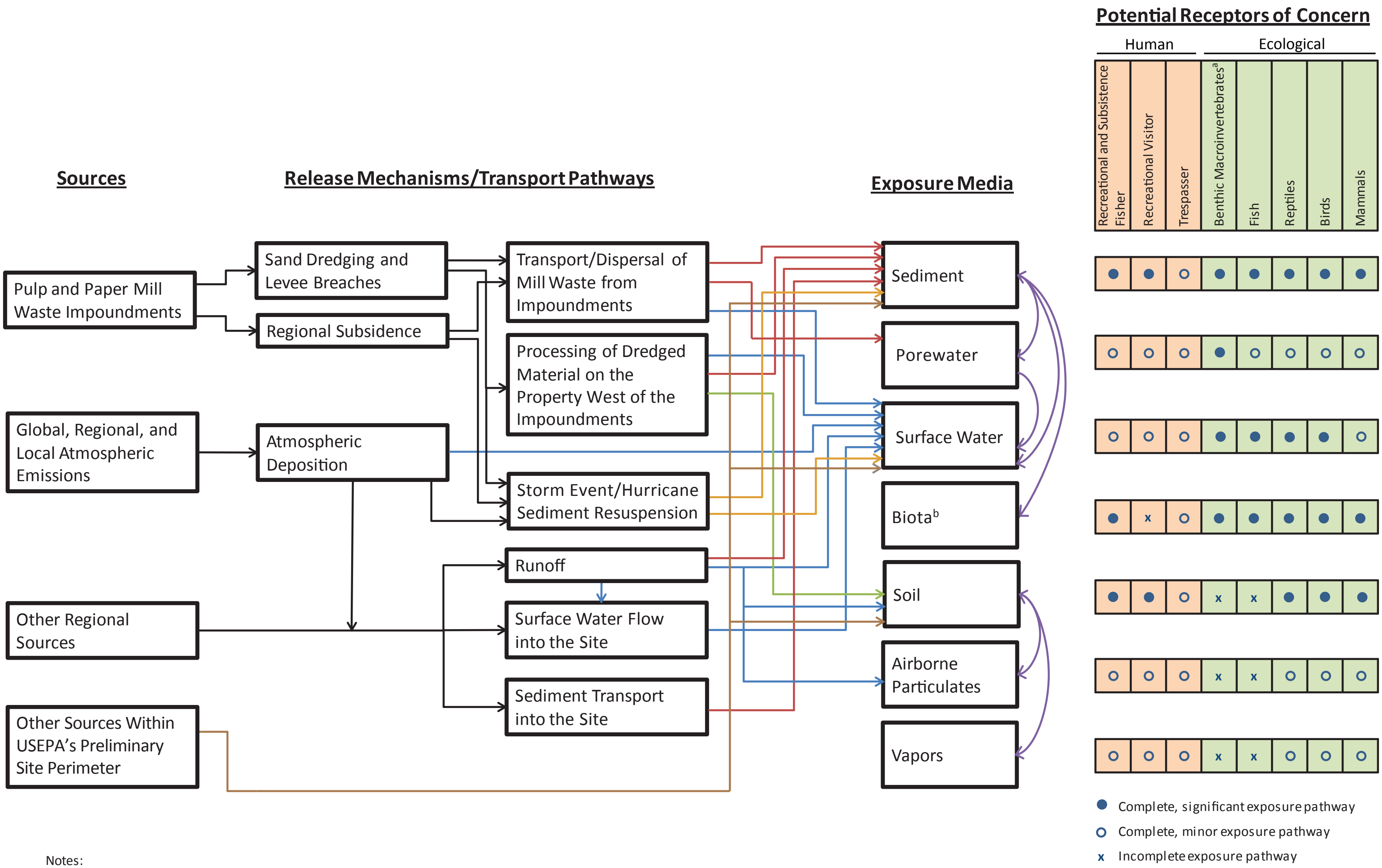
$COPC_H$	Dermal Absorption Factor for Soil/Sediment (ABSd) (% as fraction)		Relative Soil / Sediment Bioavailability Adjustment (RBA_{ss}) (% as fraction)		Relative Food Bioavailability Adjustment (RBA_{tissue}) (% as fraction)		Chemical Reduction Due to Preparation and Cooking (LOSS) (% as fraction)	
Dioxins/Furans								
Dioxins and Furans	0.03	a	0.5	b	1	d	0	d
Metals								
Arsenic (inorganic)	0.03	a	0.5	b	1	d	0	d
Cadmium	0.001	a	1	d	1	d	0	d
Chromium	0.02	c	1	d	1	d	0	d
Copper	1	d	1	d	1	d	0	d
Mercury	0.03	c	1	d	1	d	0	d
Nickel	0.04	c	1	d	1	d	0	d
Thallium	1	d	1	d	--		--	
Zinc	1	d	1	d	1	d	0	d
Polychlorinated Biphenyls								
Polychlorinated Biphenyls	0.14	a	1	d	1	d	0	d
Semivolatile Organic Compounds								
Bis(2-ethylhexyl)phthalate	0.1	a	1	d	1	d	0	d

Notes

-- = Not applicable; not a $COPC_H$ in this medium.
$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessment

a - Value is from USEPA (2004).
b - Multiple sources were used to derive this value (see Section 4.3.2 of text).
c - Value is from CalEPA (2011).
d - Conservative default assumption.

FIGURES



Exposure Media	Recreational and Subsistence Fisher	Recreational Visitor	Trespasser	Benthic Macroinvertebrates[a]	Fish	Reptiles	Birds	Mammals
Sediment	●	●	o	●	●	●	●	●
Porewater	o	o	o	●	o	o	o	o
Surface Water	o	o	o	●	●	●	●	o
Biota[b]	●	x	o	●	●	●	●	●
Soil	●	●	o	x	x	●	●	●
Airborne Particulates	o	o	o	x	x	o	o	o
Vapors	o	o	o	x	x	o	o	o

Notes:

Other regional sources may include industrial effluents, publicly owned treatment works, and stormwater.

Curved lines indicate potential transport pathways for chemicals of potential concern among exposure media.

[a]Benthic macroinvertebrates include crabs and other crustaceans and shellfish consumed by all receptors, as well as polychaetes and other infauna consumed by fish, other marine life, birds, and mammals.

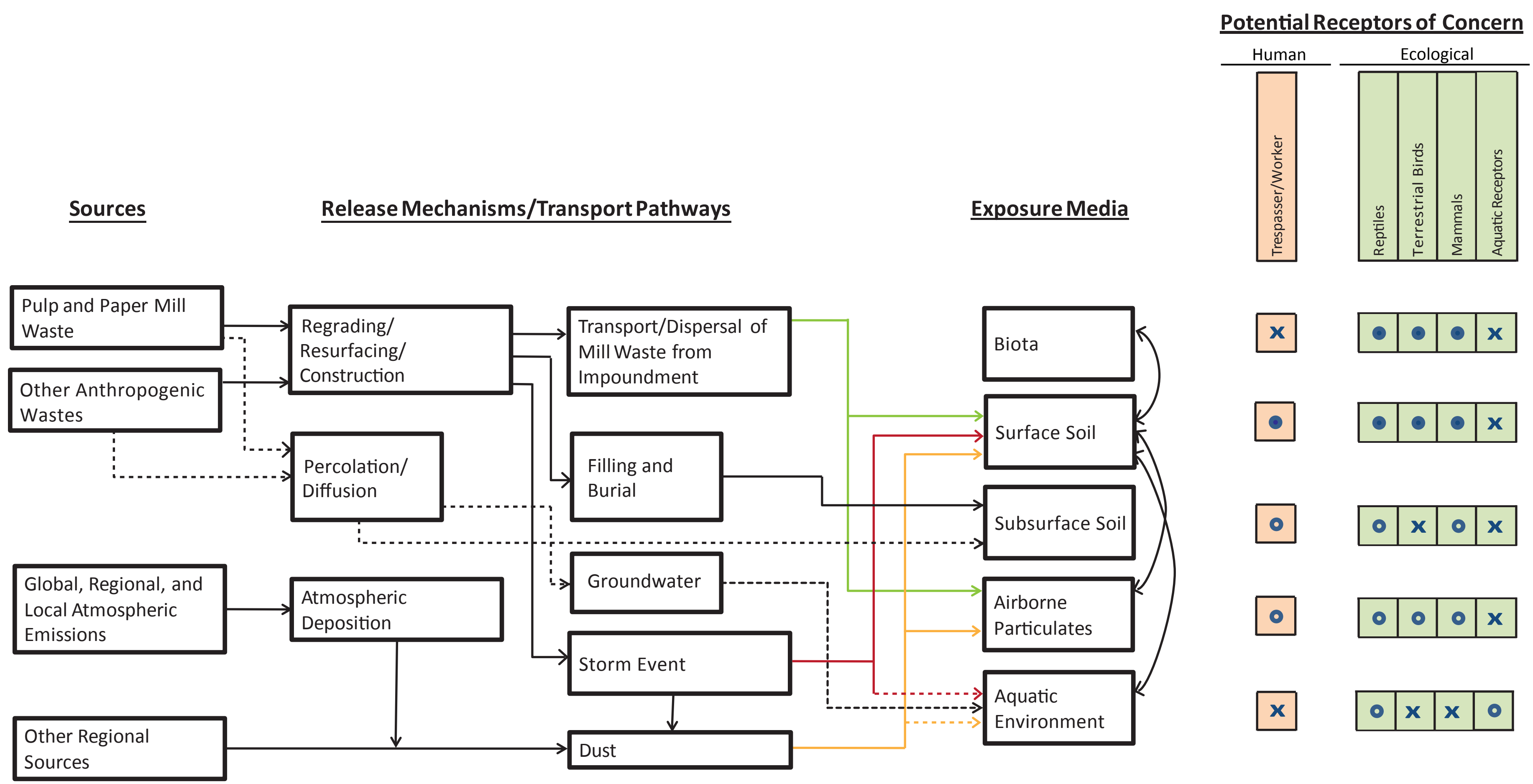
[b]Biota consumed by human receptors are expected to be fish and shellfish.

Figure 1

CSM for the Northern Impoundments and Surrounding Aquatic Environment

SJRWP Exposure Assessment Memorandum

SJRWP Superfund/MIMC and IPC



Complete, significant exposure pathway
Complete, minor exposure pathway
x Incomplete exposure pathway
- - - - - - Unknown pathway

Notes:
Local sources may include industrial air emissions, vehicle or machinery fluid leaks, or other releases resulting from ongoing commercial activities on the site.
Curved lines indicate potential transport pathways for chemicals of potential concern among exposure media.

Figure 2
CSM for the Southern Impoundment
SJRWP Exposure Assessment Memorandum
SJRWP Superfund/MIMC and IPC

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0 1,000
Feet

USEPA's Preliminary Site Perimeter
Original (1966) Perimeter of the Northern Impoundments
Area of Soil Investigation South of I-10

[a] Designation of the sand separation area is intended to be a general reference to areas in which such activities are believed to have taken place based on visual observations of aerial photography from 998 through 2002.

FEATURE SOURCES:
Aerial Imagery: 0.5-meter. Photo Date: 01/14/2009
Texas Strategic Mapping Program (StratMap), TNRIS

Figure 3
Overview of Area within USEPA's Preliminary Site Perimeter
SJRWP Exposure Assessment Memorandum
SJRWP Superfund/MIMC and IPC

NOTES:
1. Existing access gates have two 12-foot-wide leafs providing a 24-foot-wide opening.
2. "Danger" and "No Trespassing" signs have been installed on TCRA fencing.

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0 1,000
Feet

- Approximate Location of "Danger" and "No Trespassing" Signs
- TCRA Fence Line
- Coastal Water Authority Fence Line
- USEPA's Preliminary Site Perimeter

Figure 4
Fencing Introduced as Part of the Time Critical Removal Action and by the Coastal Water Authority
SJRWP Exposure Assessment Memorandum
SJRWP Superfund/MIMC and IPC

Potential Human Receptors of Concern

Exposure Media	Exposure Route	Recreational and Subsistence Fishers	Recreational Visitor	Trespasser
Sediment	Ingestion	●	●	○
	Dermal Contact	●	●	○
Porewater	Dermal Contact	○	○	○
Surface Water	Ingestion	○	○	○
	Dermal Contact	○	○	○
Fish and Shellfish	Ingestion	●	x	○
Soil	Ingestion	●	●	○
	Dermal Contact	●	●	○
Airborne Particulates	Inhalation	○	○	○
Vapors	Inhalation	○	○	○

● Potentially complete and significant exposure pathway
○ Potentially complete but minor exposure pathway
x Incomplete exposure pathway

Figure 5
Human Exposure Pathways North of I-10 and Aquatic Environments, Pre-TCRA
SJRWP Exposure Assessment Memorandum
SJRWP Superfund/MIMC and IPC

Exposure Media	Exposure Route	Potential Human Receptors of Concern: Trespasser/Worker
Soil	Ingestion	●
	Dermal contact	●
Airborne Particulates	Inhalation	○

Notes:

● Potentially complete and significant exposure pathway

○ Potentially complete but minor exposure pathway

Figure 6

Human Exposure Pathways for the Southern Impoundment Area

SJRWP Exposure Assessment Memorandum

SJRWP Superfund/MIMC and IPC

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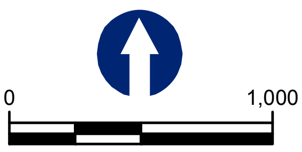

- Surface Sediment Sampling Locations
- Exposure Unit Designation
- USEPA's Preliminary Site Perimeter
- 0 Contour (NAVD 88)[a]
- -2 (feet)[b]
- -1 (feet)[b]

Notes: [a] Tidal conditions under which this contour was measured are unknown.
[b] Contours reflect pre-TCRA conditions.

Figure 7

Exposure Units for Sediment, Area North of I-10 and Aquatic Environments, Pre-TCRA

SJRWP Exposure Assessment Memorandum

SJRWP Superfund/MIMC and IPC

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0 1,000
Feet

- Surface Sediment Sampling Locations
- Exposure Unit Designation
- TCRA Fence Line
- Coastal Water Authority Fence Line
- 0 Contour (NAVD 88)[a]
- USEPA's Preliminary Site Perimeter

Note: [a] Tidal conditions under which this contour was measured are unknown.

Figure 8
Exposure Units for Sediment, Area North of I-10 and Aquatic Environments, Post-TCRA
SJRWP Exposure Assessment Memorandum
SJRWP Superfund/MIMC and IPC

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0 1,000
Feet

- Large Fish Collection Location (University of Houston and Parsons, 2009)
- Large Fish and Blue Crab Fish Collection Area
- Hardhead Catfish Fillet and Blue Crab Exposure Unit: "FCA 1"
- Hardhead Catfish Fillet and Blue Crab Exposure Unit: "FCA 2/3"
- Clam Exposure Unit: "FCA 1/3"
- Clam Exposure Unit: "FCA 2"
- Original (1966) Perimeter of the Northern Impoundments
- USEPA's Preliminary Site Perimeter

Figure 9
Exposure Units for Fish and Shellfish Tissue, Area North of I-10 and Aquatic Environments, Pre-TCRA
SJRWP Exposure Assessment Memorandum
SJRWP Superfund/MIMC and IPC

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ANCHOR QEA integral consulting inc.

Surface Soil Sampling Locations

USEPA's Preliminary Site Perimeter

0 1,000

Feet

Figure 10

Exposure Unit for Soils, Area North of I-10 and Aquatic Environments, Pre-TCRA

SJRWP Exposure Assessment Memorandum

SJRWP Superfund/MIMC and IPC

Figure 11
Exposure Unit for Soils, Area North of I-10 and Aquatic Environments, Post-TCRA
SJRWP Exposure Assessment Memorandum
SJRWP Superfund/MIMC and IPC

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- Planned Soil Core 0-2 Ft Interval Dioxins, Furans, Grainsize, TOC and All COPCs will be Analyzed [a]
- Planned Soil Core 0-2 Ft Interval, Dioxins, Furans, Grainsize and TOC will be Analyzed [a]
- Planned Monitoring Well and Colocated Soil Core [a]
- Existing Soil Core with All COPCs Analyzed (0-2 Ft Interval)
- Existing Soil Core, Dioxins and Furans Only (0-2 Ft Interval)
- Existing Surface and Shallow Subsurface Core with All COPCs Analyzed (0-6 and 6-12 Inches)

0 500

Feet

NOTES:
[a] The upper 2 feet will be divided into 0-6, 6-12 and 12-24 inch increments.

Figure 12
Exposure Unit for Surface and Shallow Subsurface Soils, South Impoundment Area Pre- and Post- TCRA
SJRWP Exposure Assessment Memorandum
SJRWP Superfund/MIMC and IPC

APPENDIX A
QUALITY ASSURANCE REVIEW OF PCB CONGENER DATA FROM THE TMDL PROGRAM

1 OVERVIEW OF APPENDIX A

This Appendix to the Exposure Assessment Memorandum provides independent quality assurance (QA) review of tissue and sediment samples collected from April 2008 through June 2009 in association with the Houston Ship Channel Dioxin Total Maximum Daily Load (TMDL) study for polychlorinated biphenyl (PCB) congeners (University of Houston and Parsons 2009, 2010). A subset of this tissue and sediment dataset is useful in support of the San Jacinto River Waste Pits remedial investigation and feasibility study (RI/FS) to characterize both baseline conditions on the Site, and tissue concentrations in background areas.

All of the data to be used for decision-making in the RI/FS must meet certain QA criteria to ensure that they are appropriate for the intended use. The data classification scheme used to characterize the extent and documentation of QA review required for any given dataset is described in Section 3.1 of the RI/FS Work Plan (Anchor QEA and Integral 2010). The result of this process is classification of discrete datasets into one of two categories: Category 1, data of known quality that are appropriate for use in decision making; and Category 2, data of unknown or suspect quality (data may be initially classified as Category 2 data because supporting QA data were not available or had not been sought out). For data in Category 2 to be reclassified as Category 1, an independent QA review and documentation of that review are necessary. This appendix provides the documentation of an independent QA review of two datasets from the TCEQ's TMDL program for PCBs:

- Attachment A-1. PCB congeners in tissue collected for TCEQ's TMDL program for PCBs. Only data collected in 2008 and 2009 were evaluated.
- Attachment A-2. PCB congeners in sediment collected for TCEQ's PCB TMDL program at Station 11193, which is within USEPA's preliminary Site perimeter.

2 REFERENCES

Anchor QEA and Integral, 2010. Final Remedial Investigation/Feasibility Study Work Plan, San Jacinto River Waste Pits Superfund Site. Prepared for McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. Prepared by Anchor QEA, LLC (Ocean Springs, MS) and Integral Consulting Inc. (Seattle, WA). November 2010.

University of Houston and Parsons, 2009. Total Maximum Daily Loads for PCBs in the Houston Ship Channel. Contract No. 582-6-70860, Work Order No. 582-6-70860-22. Quarterly Report No. 2. Prepared in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency. University of Houston and Parsons Water & Infrastructure. Available at: http://www.tceq.texas.gov/assets/public/implementation/water/tmdl/78hscpcbs/78-2009marchquarterly.pdf.

University of Houston and Parsons, 2010. Total Maximum Daily Loads for PCBs in the Houston Ship Channel. Contract No. 582-6-70860, Work Order No. 582-6-70860-29. Quarterly Report No. 2. Prepared in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency. University of Houston and Parsons Water & Infrastructure. Available at: http://www.tceq.texas.gov/assets/public/implementation/water/tmdl/78hscpcbs/78-2010marchquarterly.pdf.

ATTACHMENT A-1
DATA VERIFICATION SUMMARY REPORT: TISSUE

1 INTRODUCTION

Tissue samples were collected from April 2008 through June 2009 in association with the Houston Ship Channel Dioxin Total Maximum Daily Load (TMDL) study (University of Houston and Parsons 2009, 2010). Chemistry data that are not collected according to an approved sampling and analysis plan but which are to be used in the remedial investigation and feasibility study (RI/FS) must undergo a quality assurance (QA) review to ensure that the data are appropriate for specified uses, such as support of decision making. This process is described in Section 3.1 of the RI/FS Work Plan (Anchor QEA and Integral 2010) and classifies the data into two categories: Category 1, data of known quality that are appropriate for use in decision making, and Category 2, data of unknown or suspect quality. Tissue data for polychlorinated biphenyl (PCB) congeners from the TMDL study were initially classified as Category 2 data because supporting QA data were not available. Two QA evaluations of the 2008 and 2009 tissue samples were obtained and used to independently validate those tissue data. This Attachment A-1 documents a review of those QA evaluations to reclassify these data as Category 1. The samples reviewed are listed in Table 1.

2 EVALUATION

Data classification requires evaluation of the following factors:

- Traceability
- Comparability
- Sample integrity
- Potential measurement bias (i.e., accuracy, precision).

For data to be classified as Category 1 all of these factors must be known or supported by existing QA/QC information including: analytical methods, chain-of-custody, sample holding time, method blanks, matrix spike/matrix spike duplicates, laboratory control samples, replicates, and surrogates. The evaluation of these factors was documented in Appendix D-1 of the RI/FS Work Plan.

Data verification summary reports prepared by Parsons of Austin, Texas, were obtained from the Texas Commission on Environmental Quality (TCEQ)[1] to reevaluate the data for the 2008–2009 TMDL tissues. Data verification summary reports are included as Attachments A1.1 and A1.2. The sections below discuss the QA/QC information documented in these reports. These data verification summary reports discuss additional samples not included in

[1] http://www.tceq.texas.gov/waterquality/tmdl/78-hsc-pcbs.html

Table 1. Some QA exceptions that are discussed in the reports do not apply to the samples in Table 1.

The following flags were assigned by Parsons personnel during their review of the 2008–2009 TMDL tissue data:

Flag Key for 2008–2009 TMDL Tissue Data

F	Field duplicate exceedance
B	Blank contamination
Q	Limit of quantitation exceedance

2.1 Analytical Method

All 2008 tissue samples were analyzed by Maxxam Analytical Inc. of Burlington, Canada. All 2009 tissue samples were analyzed by Pace Analytical Services, Inc. of Minneapolis, MN. All samples were analyzed by the analytical method specified in the Quality Assurance Project Plan (QAPP; Rifai 2008 and 2009) for the TMDL study, U.S. Environmental Protection Agency (USEPA) Method 1668A (USEPA 2003).

2.2 Chain of Custody

All chain of custody procedures followed those described in the QAPP for the TMDL study.

2.3 Holding Times

The method specified analytical holding time of one year from sample collection to sample extraction was met for all samples listed in Table 1.

2.4 Method Blanks

The method blank frequency criteria (one for every 20 samples or one per extraction batch) set forth in the QAPP were met. The method blanks had many PCBs above the reporting limits. Sample results that were less than 5 times the amount found in the blank were "B" flagged to indicate the method blank contamination. Select tissue data from 2009 were "B" flagged to indicate method blank contamination; these data should be assessed as being estimated values.

2.5 Matrix Spikes/Matrix Spike Duplicates

Recoveries in the matrix spike/matrix spike duplicates (MS/MSD) met the control limits (60 to 140 percent) specified in the QAPP, with the exception of analytes in parent samples having analyte concentrations greater than 4 times the amount spiked. No results were flagged based on MS/MSD recoveries.

2.6 Laboratory Control Samples

Recoveries in the laboratory control samples met the control limits (50 to 150 percent) specified in the QAPP. No results were flagged based on laboratory control sample recoveries.

2.7 Replicates

Precision was evaluated using the relative percent difference (RPD) obtained from the parent sample/field duplicate sample results. All field duplicate results were within the control limit of 50 percent less than RPD specified in the QAPP, except for select PCB congeners; these results were flagged "F" as estimated as a result of the out-of-tolerance RPD.

2.8 Labeled Compounds

Recoveries of labeled compounds met the criteria specified in the analytical method (USEPA Method 1668A). No results were flagged based on labeled compound recoveries.

2.9 Limit of Quantitation

Most of the 2008–2009 tissue sample results met the limits of quantitation (LOQ) specified in the QAPP. Select PCB congeners within this dataset exceeded QAPP LOQs and were "Q" flagged by Parsons.

3 CONCLUSION

The samples discussed in this memorandum were collected and analyzed following the QAPP and analytical procedures. No reported results were rejected or invalidated. Based on the above review the PCB congener data for the samples listed in Table 1 are acceptable and of known quality and can be considered to be Category 1 data.

4 REFERENCES

Anchor QEA and Integral, 2010. Final Remedial Investigation/Feasibility Study Work Plan, San Jacinto River Waste Pits Superfund Site. Prepared for McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. Prepared by Anchor QEA, LLC (Ocean Springs, MS) and Integral Consulting Inc. (Seattle, WA). November 2010.

Rifai, H., 2008. Total Maximum Daily Loads for PCBs in the Houston Ship Channel System. Segments 0901, 1001, 1005, 1006, 1007, 2430, 2429, 2428, 2427, 2426, 2436, 2438, and 2421. Quality Assurance Project Plan, Expedited Amendment Request #1. Prepared for Texas Commission on Environmental Quality. Prepared by H. Rifai, University of Houston Project Manager, University of Houston (Houston, TX). June 17, 2008.

Rifai, H., 2009. Total Maximum Daily Loads for PCBs in the Houston Ship Channel System. Segments 0901, 1001, 1005, 1006, 1007, 2430, 2429, 2428, 2427, 2426, 2436, 2438, and 2421. Quality Assurance Project Plan, Revision 1. Prepared for Texas Commission on Environmental Quality. Prepared by H. Rifai, University of Houston Project Manger, University of Houston (Houston, TX). April 30, 2009.

University of Houston and Parsons, 2009. Total Maximum Daily Loads for PCBs in the Houston Ship Channel. Contract No. 582-6-70860, Work Order No. 582-6-70860-22. Quarterly Report No. 2. Prepared in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency. University of Houston and Parsons Water & Infrastructure. Available at: http://www.tceq.texas.gov/assets/public/implementation/water/tmdl/78hscpcbs/78-2009marchquarterly.pdf.

University of Houston and Parsons, 2010. Total Maximum Daily Loads for PCBs in the Houston Ship Channel. Contract No. 582-6-70860, Work Order No. 582-6-70860-29. Quarterly Report No. 2. Prepared in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency. University of Houston and Parsons Water & Infrastructure. Available at: http://www.tceq.texas.gov/assets/public/implementation/water/tmdl/78hscpcbs/78-2010marchquarterly.pdf.

USEPA, 2003. Method 1668, Revision A: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, and Tissue by HRGC/HRMS. EPA 821-R-07-004. U.S. Environmental

Protection Agency, Office of Water, Office of Science and Technology, Engineering and Analysis Division (4303T), Washington, DC. August 2003.

Table 1
2008-2009 TMDL Tissue Samples

Sample Delivery Group	Sample Date	Integral Concatenated Sample ID	Integral Database Sample ID	Data Verification Report Sample ID
A845862	4/22/2008	080422hcf11280	11280-F1-1	11280-F1-1-TISSUE
A845862	4/22/2008	080422bcf11287	11287-F1-1	11287-F1-1-TISSUE
A845862	4/29/2008	080429hcf11270	11270-F1-1	11270-F1-1-TISSUE
A845862	4/29/2008	080429spt11270	11270-F2-1	11270-F2-1-TISSUE
A845862	4/29/2008	080429hcf11274	11274-F1-1	11274-F1-1-TISSUE
A845862	4/29/2008	080429hcf13338	13338-F1-1	13338-F1-1-TISSUE
A845862	4/29/2008	080429spt13338	13338-F2-1	13338-F2-1-TISSUE
A860731	4/30/2008	080430hcf15936-dup	15936-F1-1-DUP	15936-F1-1-DUP-TISSUE
A860731	4/30/2008	080430hcf15936	15936-F1-1	15936-F1-1-TISSUE
A845862	4/30/2008	080430hcf15979-dup	15979-F1-1-DUP	15979-F1-1-DUP-TISSUE
A845862	4/30/2008	080430hcf15979	15979-F1-1	15979-F1-1-TISSUE
A845862	5/1/2008	080501hcf11264	11264-F1-1	11264-F1-1-TISSUE
A845862	5/1/2008	080501spt11264	11264-F2-1	11264-F2-1-TISSUE
A845862	5/1/2008	080501bcf16622	16622-F1-1	16622-F1-1-TISSUE
A860731	5/2/2008	080502hcf11193	11193-F1-1	11193-F1-1-TISSUE
A856461	5/28/2008	080528hcf13363-dup	13363-F1-1-DUP	13363-F1-1-DUP-TISSUE
A856461	5/28/2008	080528hcf13363	13363-F1-1	13363-F1-1-TISSUE
A860731	5/28/2008	080528spt13363	13363-F2-1	13363-F2-1-TISSUE
A860731	5/28/2008	080528hcf14560	14560-F1-1	14560-F1-1-TISSUE
A856461	5/28/2008	080528ckr14560	14560-F2-1	14560-F2-1-TISSUE
A860731	5/28/2008	080528spt14560	14560-F3-1	14560-F3-1-TISSUE
A860731	5/28/2008	080528hcf16213	16213-F1-1	16213-F1-1-TISSUE
A860731	5/28/2008	080528ckr16213	16213-F2-1	16213-F2-1
A856461	5/29/2008	080529hcf11252	11252-F1-1	11252-F1-1-TISSUE
A856461	5/29/2008	080529hcf16499	16499-F1-1	16499-F1-1-TISSUE
A856461	5/29/2008	080529hcf16618	16618-F1-1	16618-F1-1-TISSUE
A856461	5/29/2008	080529spt16618	16618-F2-1	16618-F2-1-TISSUE
A860731	5/30/2008	080530hcf11258-dup	11258-F1-1-DUP	11258-F1-1-DUP-TISSUE
A860731	5/30/2008	080530hcf11258	11258-F1-1	11258-F1-1-TISSUE
A860731	5/30/2008	080530hcf13342	13342-F1-1	13342-F1-1-TISSUE
A860731	5/30/2008	080530hcf13355	13355-F1-1	13355-F1-1-TISSUE
A860731	6/3/2008	080603ckr11258	11258-F2-1	11258-F2-1-TISSUE
A860731	6/3/2008	080603bcf11292	11292-F1-1	11292-F1-1
A860731	6/3/2008	080603ccf11347	11347-F1-1	11347-F1-1-TISSUE

Table 1
2008-2009 TMDL Tissue Samples

Sample Delivery Group	Sample Date	Integral Concatenated Sample ID	Integral Database Sample ID	Data Verification Report Sample ID
A860731	6/3/2008	080603hcf13344	13344-F1-1	13344-F1-1-TISSUE
A860731	6/3/2008	080603hcf15301	15301-F1-1	15301-F1-1-TISSUE
A860731	6/4/2008	080604bcf11132	11132-F1-1	11132-F1-1-TISSUE
A860731	6/4/2008	080604hcf11261	11261-F1-1	11261-F1-1-TISSUE
A860731	6/4/2008	080604hcf11262	11262-F1-1	11262-F1-1-TISSUE
A860731	6/4/2008	080604ckr11262	11262-F2-1	11262-F2-1-TISSUE
A860731	6/4/2008	080604ckr13355	13355-F2-1	13355-F2-1-TISSUE
A892224	8/12/2008	080812ckr11252	11252-F2-1	11252-F2-1-TISSUE
A892224	8/12/2008	080812ckr13342	13342-F2-1	13342-F2-1-TISSUE
A892224	8/13/2008	080813ckr11193	11193-F2-1	11193-F2-1-TISSUE
A892224	8/13/2008	080813ckr13344	13344-F2-1	13344-F2-1-TISSUE
A892224	8/14/2008	080814ckr15301	15301-F2-1	15301-F2-1-TISSUE
A892224	8/15/2008	080815ckr11261	11261-F2-1	11261-F2-1-TISSUE
A892224	8/15/2008	080815ckr11280	11280-F2-1	11280-F2-1-TISSUE
A892224	8/15/2008	080815ckr15936	15936-F2-1	15936-F2-1-TISSUE
A892224	8/15/2008	080815ckr16499	16499-F2-1	16499-F2-1-TISSUE
1096012	5/5/2009	090505hcf11252	11252-F1-2	11252-F1-2
1096013	5/5/2009	090505hcf11252-dup	11252-F1-2-DUP	11252-F1-2-DUP
1096013	5/5/2009	090505ckr11252	11252-F2-2	11252-F2-2
1096012	5/7/2009	090507hcf13338	13338-F1-2	13338-F1-2
1096013	5/7/2009	090507hcf14560	14560-F1-2	14560-F1-2
1096010	5/7/2009	090507hcf16499	16499-F1-2	16499-F1-2
1096012	5/18/2009	090518hcf11258	11258-F1-2	11258-F1-2
1096010	5/18/2009	090518ckr11258	11258-F2-2	11258-F2-2
1096012	5/18/2009	090518ckr13338	13338-F2-2	13338-F2-2
1096013	5/18/2009	090518hcf13342	13342-F1-2	13342-F1-2
1096013	5/18/2009	090518ckr13342	13342-F2-2	13342-F2-2
1096012	5/18/2009	090518ckr16499	16499-F2-2	16499-F2-2
1096010	5/18/2009	090518hcf16618	16618-F1-2	16618-F1-2
1096013	5/18/2009	090518ckr16618	16618-F2-2	16618-F2-2
1096012	5/19/2009	090519hcf13344	13344-F1-2	13344-F1-2
1096010	5/19/2009	090519ckr13344	13344-F2-2B	13344-F2-2B
1099534	5/20/2009	090520ccf11132	11132-F1-2	11132-F1-2
1096010	5/21/2009	090521bcf11193	11193-F1-2	11193-F1-2
1096010	5/21/2009	090521ckr11193	11193-F2-2	11193-F2-2
1096012	5/21/2009	090521hcf11193	11193-F3-2	11193-F3-2
1096010	5/21/2009	090521hcf11193-dup	11193-F3-2-DUP	11193-F3-2-DUP

Table 1
2008-2009 TMDL Tissue Samples

Sample Delivery Group	Sample Date	Integral Concatenated Sample ID	Integral Database Sample ID	Data Verification Report Sample ID
1097359	5/27/2009	090527hcf11270	11270-F1-2	11270-F1-2-UHDUP
1097359	5/27/2009	090527hcf15301	15301-F1-2	15301-F1-2-UHDUP
1097359	5/27/2009	090527hcf15936	15936-F1-2	15936-F1-2-UHDUP
1097103	5/27/2009	090527ckr15936	15936-F2-2	15936-F2-2-UHDUP
1097103	5/27/2009	090527hcf15979	15979-F1-2	15979-F1-2-UHDUP
1097103	5/28/2009	090528hcf13355	13355-F1-2	13355-F1-2-UHDUP
1097103	5/28/2009	090528ckr13355	13355-F2-2	13355-F2-2-UHDUP
1097103	5/28/2009	090528spt13355	13355-F3-2	13355-F3-2-UHDUP
1097103	5/28/2009	090528hcf13363	13363-F1-2	13363-F1-2-UHDUP
1098568	5/28/2009	090528ckr13363	13363-F2-2	13363-F2-2-AC
1097103	5/29/2009	090529hcf11264	11264-F1-2	11264-F1-2-UHDUP
1097359	5/29/2009	090529ckr11264	11264-F2-2	11264-F2-2-UHDUP
1098566	5/29/2009	090529ckr11280	11280-F2-2	11280-F2-2
1098566	5/29/2009	090529spt13363	13363-F2-2	13363-F2-2-ST
1098566	5/29/2009	090529spt13363-dup	13363-F2-2-DUP	13363-F2-2-ST-DUP
1098568	6/9/2009	090609hcf11261	11261-F1-2	11261-F1-2
1098566	6/9/2009	090609ckr11261	11261-F2-2	11261-F2-2
1098568	6/9/2009	090609hcf11262	11262-F1-2	11262-F1-2
1098566	6/9/2009	090609hcf11262-dup	11262-F1-2-DUP	11262-F1-2-DUP
1098568	6/9/2009	090609ckr11262	11262-F2-2	11262-F2-2
1099532	6/9/2009	090609bcf11274	11274-F1-2	11274-F1-2
1099532	6/10/2009	090610hcf11280	11280-F1-2	11280-F1-2
1098568	6/10/2009	090610bcf11292	11292-F1-2	11292-F1-2
1099533	6/10/2009	090610bcf11292-dup	11292-F1-2-DUP	11292-F1-2-DUP
1099532	6/12/2009	090612bcf11287	11287-F1-2	11287-F1-2
1099532	6/12/2009	090612ccf11347	11347-F1-2	11347-F1-2
1099534	6/17/2009	090617rdm15979	15979-F2-2	15979-F2-2
1099533	6/18/2009	090618hcf11265	11265-F1-2	11265-F1-2
1099533	6/18/2009	090618hcf11265-dup	11265-F1-2-DUP	11265-F1-2-DUP
1099533	6/18/2009	090618bcf16622	16622-F1-2	16622-F1-2
1099533	6/19/2009	090619hcf18322	18322-F1-2	18322-F1-2
1099532	6/24/2009	090624bcf11288	11288-F1-2	11288-F1-2
1099534	6/25/2009	090625hcf11271	11271-F1-2	11271-F1-2
1099532	7/15/2009	090715hcf17149	17149-F1-2	17149-F1-2

DATA VERIFICATION SUMMARY REPORT

for

PCBs in

FISH SAMPLES COLLECTED IN THE

HOUSTON SHIP CHANNEL SYSTEM

(Segments 2426, 2436, 2438, and 2421)

HOUSTON, TEXAS

Data Verifier: Sandra de las Fuentes (Parsons - Austin, TX)

INTRODUCTION

The following data verification summary report covers analysis of environmental samples, including forty-six (46) fish samples, four (4) field duplicate samples and three (3) blank samples collected from the Houston Ship Channel System in Houston Texas over the three month period between April 22, 2008 and August 15, 2008. The samples were analyzed for Polychlorinated Biphenyls (PCBs) as congeners and percent lipid content following laboratory Sample Delivery Group (SDG)

A845862, A856461, A892224 and A860731 (4 sets)

All samples were collected by the University of Houston and Parsons following the procedures described in the QAPP. All analyses were performed by Maxxam Analytical Inc. in Burlington, Canada following procedures outlined in the QAPP and Method 1668A for PCB congeners and an "In-House" Method for % Lipid Content.

EVALUATION CRITERIA

The data submitted by the laboratory has been reviewed and verified following the guidelines outlined in the QAPP and National Functional Guidelines for Organic and Inorganic Data (EPA 1994). Information reviewed in the data packages include sample results; the laboratory quality control results; instrument calibrations; blanks; case narrative and chain-of-custody forms. The verification protocol addressed the following parameters: method blanks, laboratory control spike recoveries, recoveries of labeled compounds (internal standards), continuing calibration verifications, laboratory and field duplicate sample percent reproducibility (%RPD), percent recovery (%R), and Level of Quantification (LOQ) standard results. The analyses and findings presented in this report are based on the reviewed information, and meeting guidelines in the QAPP (with the exceptions noted below).

POLYCHLORINATED BIPHENYLS

General

The SDGs included in this report contained the samples listed in Table 1 and analyzed for PCBs. The PCBs analyses were performed using USEPA Method 1668A (lab method: BRL SOP-00408). All samples for this SDG were collected and analyzed following the procedures and protocols outlined in the QAPP. All samples collected were prepared and analyzed within the holding times required by the method.

Table 1: Data Packages, Sample IDs and Collection Dates and Times

Sample ID	Sample Collected Date/Time	Sample Analyzed Date/Time	Holding Time (Days)	Meet DQO for Holding Time *	SDG
15979-F1-1-TISSUE	4/30/2008 0:00	6/9/2008 0:00	40.00	Y	A845862
15979-F1-1-DUP-TISSUE	4/30/2008 0:00	6/9/2008 0:00	40.00	Y	
11264-F1-1-TISSUE	5/1/2008 0:00	6/9/2008 0:00	39.00	Y	
13338-F1-1-TISSUE	4/29/2008 0:00	6/9/2008 0:00	41.00	Y	
11274-F1-1-TISSUE	4/29/2008 0:00	6/9/2008 0:00	41.00	Y	
13338-F2-1-TISSUE	4/30/2008 0:00	6/9/2008 0:00	40.00	Y	
11264-F2-1-TISSUE	5/1/2008 0:00	6/9/2008 0:00	39.00	Y	
16622-F1-1-TISSUE	5/1/2008 0:00	6/9/2008 0:00	39.00	Y	
11270-F2-1-TISSUE	4/29/2008 0:00	6/9/2008 0:00	41.00	Y	
11270-F1-1-TISSUE	4/29/2008 0:00	6/9/2008 0:00	41.00	Y	
11280-F1-1-TISSUE	4/22/2008 0:00	6/9/2008 0:00	48.00	Y	
11287-F1-1-TISSUE	4/22/2008 0:00	6/9/2008 0:00	48.00	Y	
13363-F1-1-DUP-TISSUE	5/29/2008 0:00	9/12/2008 0:00	106.00	Y	A856461
14560-F2-1-TISSUE	5/29/2008 0:00	9/12/2008 0:00	106.00	Y	
13363-F1-1-TISSUE	5/29/2008 0:00	9/12/2008 0:00	106.00	Y	
16618-F2-1-TISSUE	5/29/2008 0:00	9/12/2008 0:00	106.00	Y	
16618-F1-1-TISSUE	5/29/2008 0:00	9/12/2008 0:00	106.00	Y	
16499-F1-1-TISSUE	5/29/2008 0:00	9/12/2008 0:00	106.00	Y	
11252-F1-1-TISSUE	5/29/2008 0:00	9/12/2008 0:00	106.00	Y	
11292-F1-1	6/3/2008 0:00	9/18/2008 0:00	107.00	Y	A860731
BLANK-B-F2-1	6/5/2008 0:00	9/18/2008 0:00	105.00	Y	
BLANK-A-F2-1	6/5/2008 0:00	9/18/2008 0:00	105.00	Y	
BLANK-C-F1-1	6/5/2008 0:00	9/18/2008 0:00	105.00	Y	

Sample ID	Sample Collected Date/Time	Sample Analyzed Date/Time	Holding Time (Days)	Meet DQO for Holding Time *	SDG
11262-F1-1-TISSUE	6/4/2008 0:00	10/2/2008 0:00	120.00	Y	A860731
15936-F1-1-DUP-TISSUE	4/30/2008 0:00	10/3/2008 0:00	156.00	Y	
14560-F1-1-TISSUE	5/28/2008 0:00	10/3/2008 0:00	128.00	Y	
13344-F1-1-TISSUE	5/30/2008 0:00	10/3/2008 0:00	126.00	Y	
15301-F1-1-TISSUE	5/30/2008 0:00	10/3/2008 0:00	126.00	Y	
16213-F1-1-TISSUE	5/28/2008 0:00	10/3/2008 0:00	128.00	Y	
11193-F1-1-TISSUE	5/2/2008 0:00	10/3/2008 0:00	154.00	Y	
15936-F1-1-TISSUE	4/30/2008 0:00	10/3/2008 0:00	156.00	Y	
11258-F1-1-TISSUE	5/30/2008 0:00	10/3/2008 0:00	126.00	Y	
11258-F1-1-DUP-TISSUE	5/30/2008 0:00	10/6/2008 0:00	129.00	Y	
13342-F1-1-TISSUE	5/30/2008 0:00	10/6/2008 0:00	129.00	Y	
11261-F1-1-TISSUE	6/1/2008 0:00	10/6/2008 0:00	127.00	Y	
11347-F1-1-TISSUE	6/3/2008 0:00	10/6/2008 0:00	125.00	Y	
11132-F1-1-TISSUE	6/4/2008 0:00	10/6/2008 0:00	124.00	Y	
14560-F2-1-TISSUE	5/28/2008 0:00	9/19/2008 0:00	114.00	Y	A860731
13363-F2-1-TISSUE	5/28/2008 0:00	9/19/2008 0:00	114.00	Y	
11262-F2-1-TISSUE	6/4/2008 0:00	9/19/2008 0:00	107.00	Y	
13355-F2-1-TISSUE	6/4/2008 0:00	9/19/2008 0:00	107.00	Y	
11258-F2-1-TISSUE	6/3/2008 0:00	9/19/2008 0:00	108.00	Y	
13355-F1-1-TISSUE	5/30/2008 0:00	9/19/2008 0:00	112.00	Y	
11280-F2-1-TISSUE	8/15/2008 0:00	10/8/2008 0:00	54.00	Y	A892224
11261-F2-1-TISSUE	8/15/2008 0:00	10/8/2008 0:00	54.00	Y	
15936-F2-1-TISSUE	8/15/2008 0:00	10/9/2008 0:00	55.00	Y	
16499-F2-1-TISSUE	8/15/2008 0:00	10/9/2008 0:00	55.00	Y	
11252-F2-1-TISSUE	8/12/2008 0:00	10/9/2008 0:00	58.00	Y	
15301-F2-1-TISSUE	8/14/2008 0:00	10/9/2008 0:00	56.00	Y	
11193-F2-1-TISSUE	8/13/2008 0:00	10/9/2008 0:00	57.00	Y	
13342-F2-1-TISSUE	8/12/2008 0:00	10/9/2008 0:00	58.00	Y	
16213-F2-1	5/28/2008 0:00	10/8/2008 0:00	133.00	Y	A860731
13344-F2-1-TISSUE	8/13/2008 0:00	10/30/2008 0:00	78.00	Y	A892224

Accuracy

Accuracy was evaluated using the %R results for the blank spike samples (BS), Limit of Quantification (LOQ) samples, and labeled compound spikes.

The BS, LOQ and labeled compound spike recoveries %Rs were within method acceptance criteria, except for the congeners listed in “PCB_QC_Fish_UH” worksheet “PCB Fish Flags”. All LOQ failures are flagged “Q”, blank spike failures are flagged

"S" and labeled compound spike recovery failures are flagged "R". All associated congeners are flagged according to the QC failure type.

Precision

Precision was evaluated using the Relative Percent Difference (%RPD) obtained from the parent sample/field duplicate sample results. The following samples were collected and analyzed in duplicate for field duplicate QC purposes: 15979-F1-Tissue (collected 4/30/08), 13363-F1-1-Tissue (collected 5/29/08), 15936-F1-1-Tissue (collected 4/30/08), and 11258-F1-1-Tissue (collected 5/30/08). All field duplicate results were within QAPP tolerance except for the congeners listed in "PCB_QC_Fish_UH" worksheet "PCB Fish Flags". Both the parent and field duplicate samples were flagged "F" as estimated due to the out of tolerance % RPD. All associated congeners, that weren't previously flagged "J", "B" or "U" by the lab, were flagged as estimated ("F") by the data verifier.

Lab duplicates of fish analyses were not possible due to insufficient media.

Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents actual site conditions. Representativeness has been evaluated by:

* Comparing the chain-of-custody procedures to those described in the QAPP;
* Evaluating holding times; and
* Examining method blanks for contamination of samples during analysis.

The samples in this SDG were collected and analyzed following the QAPP, COC and analytical procedures. All samples were prepared and analyzed with the holding times required for the analysis.

All initial calibration criteria were met.

All continuing calibration criteria (BS) were met.

All LOQ standard criteria were met, with the exception of those listed in the accuracy table.

There was at least one method blank analyzed with each batch associated with the PCBs analyses in each SDG. The method blanks had many PCBs of concern above the RLs. The sample results that were less than five (5) times the amount found in the blank were "B" flagged for having blank contamination.

Completeness

Completeness has been evaluated by comparing the total number of samples collected with the total number of samples with valid analytical data.

No reported results for samples in this SDG have been rejected or invalidated. The completeness for this SDG is 100% compared to the minimum acceptance limit of 90%.

Flag Key:
H = Holding time exceedance
I = Ion ration failure
F = Field dup exceedance
L = Lab dup exceedance
S = Blank spike or lab control spike exceedance
Q = Limit of Quantitation (LOQ) exceedance
R = Surrogate/Internal Standard exceedance
J = Estimated by lab
U = Non-detected above MDL
B = Blank Contamination

DATA VERIFICATION SUMMARY REPORT

FOR PCBS IN FISH SAMPLES COLLECTED IN THE

HOUSTON SHIP CHANNEL SYSTEM

(Segments 0901, 1001, 1005, 1006, 1007, 2420, 2429,

2428, 2427, 2426, 2436, 2438, and 2421)

HOUSTON, TEXAS

Data Verifier: Sandra de las Fuentes (Parsons - Austin, TX)

INTRODUCTION

The following data verification summary report covers analysis of environmental samples, including Fifty-eight (58) fish samples and six (6) field duplicate samples collected from the Houston Ship Channel System in Houston Texas over a two month between May 5, 2009 and June 25, 2009. The samples were analyzed for Polychlorinated Biphenyls (PCBs) as congeners and percent lipid content following laboratory Sample Delivery Group (SDG)

1096010, 1096012, 1096013, 1097359, 1097103, 1098566, 1098568, 1099532, 1099533, and 1099534.

All samples were collected by the University of Houston and Parsons following the procedures described in the QAPP. All analyses were performed by Pace Analytical Services, Inc. in Minneapolis, Minnesota, following procedures outlined in the QAPP and Method 1668A for PCB congeners and an “In-House” Method for % Lipid Content.

EVALUATION CRITERIA

The data submitted by the laboratory has been reviewed and verified following the guidelines outlined in the QAPP and National Functional Guidelines for Organic and Inorganic Data (EPA 1994). Information reviewed in the data packages include sample results; the laboratory quality control results; instrument calibrations; blanks; case narrative and chain-of-custody forms. The verification protocol addressed the following parameters: method blanks, laboratory control spike recoveries, recoveries of labeled compounds (internal standards), continuing calibration verifications, laboratory and field duplicate sample percent reproducibility (%RPD), percent recovery (%R), and Level of Quantification (LOQ) standard results. The analyses and findings presented in this report are based on the reviewed information, and meeting guidelines in the QAPP (with the exceptions noted below).

Note: Lipid content has been reviewed and meets QAPP guidelines.

POLYCHLORINATED BIPHENYLS

General

The SDGs included in this report contained the samples listed in Table 1 and analyzed for PCBs. The PCBs analyses were performed using USEPA Method 1668A. All samples for this SDG were collected and analyzed following the procedures and protocols outlined in the QAPP. All samples collected were prepared and analyzed within the holding times required by the method.

Table 1: Data Packages, Sample IDs and Collection Dates and Times

					Meet DQO for Holding Time
1096010	16618-F1-2	05/18/09	06/19/2009	32	Y
	11193-F3-2-DUP	05/21/09	06/20/2009	30	Y
	16499-F1-2	05/7/09	06/20/2009	44	Y
	11193-F2-2	05/21/09	06/20/2009	30	Y
	11193-F1-2	05/21/09	06/19/2009	29	Y
	13344-F2-2B	05/19/09	06/20/2009	32	Y
	11258-F2-2	05/18/09	06/20/2009	33	Y
1096012	11193-F3-2	05/21/09	06/20/2009	30	Y
	16499-F2-2	05/18/09	06/21/2009	34	Y
	13338-F1-2	05/7/09	06/20/2009	44	Y
	13344-F1-2	05/19/09	06/20/2009	32	Y
	13338-F2-2	05/18/09	06/20/2009	33	Y
	11252-F1-2	05/5/09	06/20/2009	46	Y
	11258-F1-2	05/18/09	06/20/2009	33	Y
1096013	16618-F2-2	05/18/09	06/21/2009	34	Y
	14560-F1-2	05/7/09	06/21/2009	45	Y
	13342-F2-2	05/18/09	06/21/2009	34	Y
	11252-F1-2-DUP	05/5/09	06/21/2009	47	Y
	11252-F2-2	05/5/09	06/21/2009	47	Y
	13342-F1-2	05/18/09	06/21/2009	34	Y
1097359	11264-F2-2-UHDUP	05/29/09	06/29/2009	31	Y
	11270-F1-2-UHDUP	05/27/09	06/29/2009	33	Y
	15301-F1-2-UHDUP	05/27/09	06/29/2009	33	Y
	15936-F1-2-UHDUP	05/27/09	06/28/2009	32	Y
1097103	11264-F1-2-UHDUP	05/29/09	06/27/2009	29	Y
	13355-F1-2-UHDUP	05/28/09	06/28/2009	31	Y
	13355-F2-2-UHDUP	05/28/09	06/27/2009	30	Y
	13355-F3-2-UHDUP	05/28/09	07/02/2009	35	Y
	13363-F1-2-UHDUP	05/28/09	06/27/2009	30	Y
	15936-F2-2-UHDUP	05/27/09	06/27/2009	31	Y
	15979-F1-2-UHDUP	05/27/09	06/28/2009	32	Y
1098566	13363-F2-2-ST	05/29/09	07/20/2009	52	Y

					Meet DQO for Holding Time
	11262-F1-2-DUP	06/9/09	07/20/2009	41	Y
	11261-F2-2	06/9/09	07/20/2009	41	Y
	11280-F2-2	05/29/09	07/20/2009	52	Y
	13363-F2-2-ST-DUP	05/29/09	07/27/2009	59	Y
1098568	11262-F2-2	06/9/09	07/27/2009	48	Y
	11292-F1-2	06/10/09	07/27/2009	47	Y
	13363-F2-2-AC	05/28/09	07/26/2009	59	Y
	11261-F1-2	06/9/09	07/26/2009	47	Y
	11262-F1-2	06/9/09	07/26/2009	47	Y
1099532	11274-F1-2	06/19/09	07/29/2009	40	Y
	11287-F1-2	06/12/09	07/29/2009	47	Y
	11347-F1-2	06/12/09	07/29/2009	47	Y
	17149-F1-2	07/15/09	07/29/2009	14	Y
	11280-F1-2	06/10/09	07/29/2009	49	Y
	11288-F1-2	06/24/09	07/29/2009	35	Y
1099533	11265-F1-2-DUP	06/19/2009	07/30/2009	41	Y
	18322-F1-2	06/19/2009	07/30/2009	41	Y
	11265-F1-2	06/18/2009	07/30/2009	42	Y
	BLANKA-F2-2	06/18/2009	07/30/2009	42	Y
	16622-F1-2	06/18/2009	07/30/2009	42	Y
	11292-F1-2-DUP	06/10/2009	07/30/2009	50	Y
1099534	11132-F1-2	05/20/2009	07/30/2009	71	Y
	11271-F1-2	06/25/2009	07/30/2009	35	Y
	15979-F2-2	06/17/2009	07/30/2009	43	Y
	BLANKB-F2-2	06/18/2009	07/30/2009	42	Y
	BLANKC-F2-2	06/18/2009	07/30/2009	42	Y

Accuracy

Accuracy was evaluated using the %R results for the blank spike samples (BS), Limit of Quantification (LOQ) samples, and labeled compound spikes.

The BS, LOQ and labeled compound spike recoveries %Rs were within method acceptance criteria, except for the congeners listed in “PCB_QC_Fish_Pace_UH_0910(P2)” worksheet “PCB Fish Flags”. All LOQ failures are flagged “Q”, blank spike failures are flagged “S”, and labeled compound spike recovery failures are flagged “R”. All associated congeners are flagged according to the QC failure type.

Precision

Precision was evaluated using the Relative Percent Difference (%RPD) obtained from the parent sample/field duplicate sample results. The following samples were collected and analyzed in duplicate for field duplicate QC purposes: 11193-F3-2 (collected 5/21/09), 11252-F1-2 (collected 5/5/09), 13363-F2-2 (collected 5/29/09), 11262-F1-2 (collected 6/9/09), 11292-F1-2 (collected 6/10/09), and 11265-F1-2 (collected 6/19/09). All field duplicate results were within QAPP tolerance except for the congeners listed in "PCB_QC_Fish_Pace_UH_2009(P2)" worksheet "PCB Fish Flags". Both the parent and field duplicate samples were flagged "F" as estimated due to the out of tolerance % RPD. All associated congeners, that weren't previously flagged "J", "B" or "U" by the lab, were flagged as estimated ("F") by the data verifier.

The overall frequency of LD and FD is as follows:

QC Frequency for PCB Fish Samples						
						Frequency of LD
1096010	6	1	6	0	17%	0%
1096012	7	0	7	0	0%	0%
1096013	5	1	5	0	20%	0%
1097359	4	0	4	0	0%	0%
1097103	7	0	7	0	0%	0%
1098566 1098568	8	2	8	0	25%	0%
1099532	6	0	6	0	0%	0%
1099533	4	2	6	0	50%	0%
1099534	5	0	5	0	0%	0%
				Overall Frequency	**11.5%**	**0.0%**

The overall frequency met the required criteria for FD of 5%. Laboratory duplicates were not possible for these matrices due to insufficient media. An "F" flag was applied to the parent and duplicate congeners that was greater than 50% RPD.

Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents actual site conditions. Representativeness has been evaluated by:

* Comparing the chain-of-custody procedures to those described in the QAPP;
* Evaluating holding times; and
* Examining method blanks for contamination of samples during analysis.

The samples in this SDG were collected and analyzed following the QAPP, COC and analytical procedures. All samples were prepared and analyzed with the holding times required for the analysis.

All initial calibration criteria were met.

All continuing calibration criteria (BS) were met.

All LOQ standard criteria were met, with the exception of those listed in "PCB_QC_Fish_Pace_UH_2009(P2)" worksheet "PCB Fish Flags".

There was at least one method blank analyzed with each batch associated with the PCBs analyses in each SDG. The method blanks had some PCBs of concern above the RLs. The sample results that were less than five (5) times the amount found in the blank were "B" flagged for having blank contamination.

Completeness

Completeness has been evaluated by comparing the total number of samples collected with the total number of samples with valid analytical data.

No reported results for samples in this SDG have been rejected or invalidated. The completeness for this SDG is 100% compared to the minimum acceptance limit of 90%.

COMPARABILITY

All data was generated using contract-specific standard methods and reported with known data quality, type of analysis, units, etc.

DATA USABILITY

All calculations were spot checked and verified. All data in this SDG are considered usable for the purposes of this project.

ATTACHMENT A-2
DATA VERIFICATION SUMMARY REPORT: SEDIMENT

1 INTRODUCTION

Sediment samples from location 11193 were collected on May 2, 2008 (two sediments) and May 20, 2009 (one sediment) in association with the Houston Ship Channel Dioxin Total Maximum Daily Load (TMDL) study (University of Houston and Parsons 2009, 2010). Sediment chemistry data used in the remedial investigation and feasibility study (RI/FS) but not collected specifically according to a U.S. Environmental Protection Agency (USEPA)-approved sampling and analysis plan must undergo a quality assurance (QA) review to ensure that the data are appropriate for use. This process is described in Section 3.1 of the RI/FS Work Plan (Anchor QEA and Integral 2010) and classifies the data into two categories—Category 1, data of known quality that are appropriate for use in decision making, and Category 2, data of unknown or suspect quality. Sediment data for polychlorinated biphenyl (PCB) congeners from the TMDL study were initially classified as Category 2 data because supporting QA data were not available. Two QA evaluations of the 2008 and 2009 sediment samples were obtained and this appendix documents a review of those QA evaluations to reclassify these data as Category 1. The samples reviewed are listed below:

SDG	Sample Date	Data Verification Report Sample ID
A845781	5/2/2008	11193-SE-1
A845781	5/2/2008	11193-SE-1-Dup
1096016	5/20/2009	11193-SE-2

2 EVALUATION

Data are classified into categories by evaluating the following factors:

- Traceability
- Comparability
- Sample integrity
- Potential measurement bias (i.e., accuracy, precision).

For data to be classified as Category 1, all of these factors must be known or supported by existing quality assurance/quality control (QA/QC) information including analytical methods, chain-of-custody, sample holding time, method blanks, matrix spike/matrix spike duplicates, laboratory control samples, replicates, and surrogates. The evaluation of these factors is documented in Appendix D-1 of the RI/FS Work Plan.

Data verification summary reports for the subject sediment samples and prepared by Parsons of Austin, Texas, were obtained from the Texas Commission on Environmental Quality[1] to evaluate the data for the 2008–2009 TMDL sediments and are included as Attachments A2.1 and A2.2. The sections below discuss the QA/QC information documented in these reports. These data verification summary reports discuss samples from TMDL monitoring stations other than station 11193, which are not included in this memorandum. Some QA exceptions discussed in the attached reports do not apply to the samples discussed in this memorandum.

The following flags were assigned by Parsons personnel during their review of the 2008–2009 TMDL sediment data:

Data Flags for 2008–2009 TMDL Sediment Data

F	Field duplicate exceedance
Q	Limit of quantitation exceedance

2.1 Analytical Method

The 2008 sediment samples were analyzed by Maxxam Analytical Inc. of Burlington, Canada. The 2009 sediment samples were analyzed by Pace Analytical Services, Inc. of Minneapolis, MN. All samples were analyzed by USEPA Method 1668A (USEPA 2003), the analytical method specified in the TMDL study Quality Assurance Project Plan (QAPP; Rifai 2008, 2009).

2.2 Chain of Custody

All chain of custody procedures followed those described in the QAPP for the TMDL study.

2.3 Holding Times

The method specified analytical holding times of 1 year from sample collection to sample extraction and 1 year from sample extraction to sample analysis were met for all samples discussed in this memorandum.

[1] http://www.tceq.texas.gov/waterquality/tmdl/78-hsc-pcbs.html

2.4 Method Blanks

The method blank frequency criteria (one for every 20 samples or one per extraction batch) set forth in the QAPP were met. The method blanks had many PCBs detected above the reporting limits. Sample results that were less than five times the amount found in the blank were "B" flagged to indicate the method blank contamination. No results were flagged based on method blank contamination.

2.5 Matrix Spikes/Matrix Spike Duplicates

Recoveries in the matrix spike/matrix spike duplicates (MS/MSD) met the control limits (60 to 140 percent) specified in the QAPP, with the exception of analytes in parent samples having analyte concentrations greater than four times the amount spiked. No results were flagged based on MS/MSD recoveries.

2.6 Laboratory Control Samples

Recoveries in the laboratory control samples met the control limits (50 to 150 percent) specified in the QAPP. No results were flagged based on laboratory control sample recoveries.

2.7 Replicates

Precision was evaluated using the relative percent difference (RPD) obtained from the parent sample/field duplicate sample results. Most RPDs were within the control limit of less than 50 percent specified in the QAPP. When RPDs were greater than 50 percent, the results were flagged "F" as estimated by Parsons. Select PCB congeners associated with samples 11193-SE-1 and 11193-SE-1-DUP (collected in 2008) were "F" flagged by Parsons.

2.8 Labeled Compounds

Recoveries of labeled compounds met the criteria specified in the analytical method (USEPA Method 1668A). No results were flagged based on labeled compound recoveries.

2.9 Limit of Quantitation

Most of the 2008–2009 sediment sample results associated with location 11193 met the limits of quantitation (LOQ) specified in the QAPP. Select PCB congeners associated with sample 11193-SE-2 (collected in 2009) exceeded QAPP LOQs and were "Q" flagged by Parsons.

3 CONCLUSION

The samples discussed in this memo were collected and analyzed following the QAPP and analytical procedures. No reported results were rejected or invalidated. Based on the above review the PCB congener data for the samples discussed in this memorandum are acceptable and of known quality and can be considered to be Category 1 data.

4 REFERENCES

Anchor QEA and Integral, 2010. Final Remedial Investigation/Feasibility Study Work Plan, San Jacinto River Waste Pits Superfund Site. Prepared for McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. Prepared by Anchor QEA, LLC, Ocean Springs, MS, and Integral Consulting Inc., Seattle, WA. November 2010.

Rifai, H., 2008. Total Maximum Daily Loads for PCBs in the Houston Ship Channel System. Segments 0901, 1001, 1005, 1006, 1007, 2430, 2429, 2428, 2427, 2426, 2436, 2438, and 2421. Quality Assurance Project Plan, Expedited Amendment Request #1. Prepared for Texas Commission on Environmental Quality. Prepared by H. Rifai, University of Houston Project Manager, University of Houston, Houston, TX. June 17, 2008.

Rifai, H., 2009. Total Maximum Daily Loads for PCBs in the Houston Ship Channel System. Segments 0901, 1001, 1005, 1006, 1007, 2430, 2429, 2428, 2427, 2426, 2436, 2438, and 2421. Quality Assurance Project Plan, Revision 1. Prepared for Texas Commission on Environmental Quality. Prepared by H. Rifai, University of Houston Project Manager, University of Houston, Houston, TX. April 30, 2009.

University of Houston and Parsons, 2009. Total Maximum Daily Loads for PCBs in the Houston Ship Channel. Contract No. 582-6-70860, Work Order No. 582-6-70860-22. Quarterly Report No. 2. Prepared in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency. University of Houston and Parsons Water & Infrastructure. Available at:

http://www.tceq.texas.gov/assets/public/implementation/water/tmdl/78hscpcbs/78-2009marchquarterly.pdf.

University of Houston and Parsons, 2010. Total Maximum Daily Loads for PCBs in the Houston Ship Channel. Contract No. 582-6-70860, Work Order No. 582-6-70860-29. Quarterly Report No. 2. Prepared in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency. University of Houston and Parsons Water & Infrastructure. Available at: http://www.tceq.texas.gov/assets/public/implementation/water/tmdl/78hscpcbs/78-2010marchquarterly.pdf.

USEPA, 2003. Method 1668, Revision A: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, and Tissue by HRGC/HRMS. EPA 821-R-07-004. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Engineering and Analysis Division (4303T), Washington, DC. August 2003.

DATA VERIFICATION SUMMARY REPORT

for

PCBs and TOC in

SEDIMENT SAMPLES COLLECTED IN THE

HOUSTON SHIP CHANNEL SYSTEM

(Segments 2426, 2436, 2438, and 2421)

HOUSTON, TEXAS

Data Verifier: Sandra de las Fuentes (Parsons - Austin, TX)

INTRODUCTION

The following data verification summary report covers analysis of environmental sediment samples, including ninety (90) sediment samples and ten (10) field duplicate, collected from the Houston Ship Channel System in Houston Texas over the one month period between April 24, 2008 and July 13, 2008. The samples were analyzed for Polychlorinated Biphenyls (PCBs) as congeners and Total Organic Carbon (TOC) following laboratory Sample Delivery Groups (SDGs)

A845781, A855832, A860731, A861230, A877854, A877902 (3 sets), A877812, and A884606

All samples were collected by the University of Houston and Parsons following the procedures described in the QAPP. All analyses were performed by Maxxam Analytical Inc. in Burlington, Canada following procedures outlined in the QAPP and Method 1668A for PCB congeners. Maxxam Analytical Inc. sent the TOC samples to Maxxam Analytic Mississauga in Ontario, Canada for analysis following the LECO Combustion method.

EVALUATION CRITERIA

The data submitted by the laboratory has been reviewed and verified following the guidelines outlined in the QAPP and National Functional Guidelines for Organic and Inorganic Data (EPA 1994). Information reviewed in the data packages include sample results; the laboratory quality control results; instrument calibrations; blanks; case narrative and chain-of-custody forms. The verification protocol addressed the following parameters: method blanks, laboratory control spike recoveries, recoveries of labeled compounds (internal standards), continuing calibration verifications, laboratory and field duplicate sample percent reproducibility (%RPD), percent recovery (%R), and Level of Quantification (LOQ) standard results. The analyses and findings presented in this report are based on the reviewed information, and meeting guidelines in the QAPP (with the exceptions noted below).

POLYCHLORINATED BIPHENYLS

General

The SDGs included in this report contained the samples listed in Table 1 and analyzed for PCBs. The PCBs analyses were performed using USEPA Method 1668A (lab method: BRL SOP-00408). All samples for this SDG were collected and analyzed following the procedures and protocols outlined in the QAPP. All samples collected were prepared and analyzed within the holding times required by the method. Some sediment samples required dilution due to high PCBs and/or matrix interference.

Table 1: Data Packages, Sample IDs and Collection Dates and Times

SDG	Sample ID	Sample Collected Date/Time	Sample Analyzed Date/Time	Holding Time (Days)	Meet DQO for Holding Time *
A845781	13338-SE-1	4/24/2008 0:00	6/5/2008 0:00	42.00	Y
	11287-SE-1	4/28/2008 0:00	6/9/2008 0:00	42.00	Y
	11274-SE-1	4/28/2008 0:00	6/9/2008 0:00	42.00	Y
	11270-SE-1	4/29/2008 0:00	6/9/2008 0:00	41.00	Y
	15979-SE-1	4/30/2008 0:00	6/9/2008 0:00	40.00	Y
	16622-SE-1	5/1/2008 0:00	6/9/2008 0:00	39.00	Y
	11280-SE-1	4/30/2008 0:00	6/6/2008 0:00	37.00	Y
	11264-SE-1	5/2/2008 0:00	6/9/2008 0:00	38.00	Y
	11193-SE-1-Dup	5/2/2008 0:00	6/8/2008 0:00	37.00	Y
	11193-SE-1	5/2/2008 0:00	6/9/2008 0:00	38.00	Y
A855832	16213-SE-1-SOIL	5/27/2008 0:00	6/18/2008 0:00	22.00	Y
	11252-SE-1-SOIL	5/27/2008 0:00	6/18/2008 0:00	22.00	Y
	14560-SE-1-SOIL	5/27/2008 0:00	6/18/2008 0:00	22.00	Y
	13363-SE-1-SOIL	5/27/2008 0:00	6/18/2008 0:00	22.00	Y
	16499-SE-1-SOIL	5/27/2008 0:00	6/18/2008 0:00	22.00	Y
	16618-SE-1-SOIL	5/29/2008 0:00	6/18/2008 0:00	20.00	Y
	13355-SE-1-SOIL	5/29/2008 0:00	6/18/2008 0:00	20.00	Y
A860731	11347-SE-1	6/2/2008 0:00	7/10/2008 0:00	38.00	Y
	13344-SE-1	6/2/2008 0:00	7/10/2008 0:00	38.00	Y
	15301-SE-1	6/2/2008 0:00	7/10/2008 0:00	38.00	Y
	15301-SE-1-DUP	6/2/2008 0:00	7/10/2008 0:00	38.00	Y
	11258-SE-1	6/2/2008 0:00	7/30/2008 0:00	58.00	Y

SDG	Sample ID	Sample Collected Date/Time	Sample Analyzed Date/Time	Holding Time (Days)	Meet DQO for Holding Time *
	TRIP2-SE-1	6/4/2008 0:00	7/10/2008 0:00	36.00	Y
	TRIP1-SE-1	6/4/2008 0:00	7/10/2008 0:00	36.00	Y
	11132-SE-1	6/4/2008 0:00	7/10/2008 0:00	36.00	Y
	11261-SE-1	6/4/2008 0:00	7/10/2008 0:00	36.00	Y
	11262-SE-1	6/4/2008 0:00	7/10/2008 0:00	36.00	Y
	13342-SE-1	6/4/2008 0:00	7/10/2008 0:00	36.00	Y
A861230	11258-SE-1-DUP - SOIL	6/2/2008 0:00	7/10/2008 0:00	38.00	Y
	11292-SE-1	6/2/2008 0:00	7/10/2008 0:00	38.00	Y
A877854	C-001-Se-1	7/12/2008 0:00	7/30/2008 0:00	18.00	Y
	C-002-Se-1	7/12/2008 0:00	7/30/2008 0:00	18.00	Y
	C-003-Se-1	7/12/2008 0:00	7/30/2008 0:00	18.00	Y
	C-004-Se-1	7/12/2008 0:00	7/30/2008 0:00	18.00	Y
	C-004-Se-1-A	7/12/2008 0:00	7/30/2008 0:00	18.00	Y
	C-004-Se-1-B	7/12/2008 0:00	7/30/2008 0:00	18.00	Y
	C-004-Se-1-C	7/12/2008 0:00	7/30/2008 0:00	18.00	Y
	C-004-Se-1-D	7/12/2008 0:00	7/30/2008 0:00	18.00	Y
	C-004-Se-1-E	7/12/2008 0:00	7/30/2008 0:00	18.00	Y
	C-005-Se-1	7/12/2008 0:00	7/30/2008 0:00	18.00	Y
	C-006-Se-1	7/13/2008 0:00	7/30/2008 0:00	17.00	Y
	T-013-Se-1	7/15/2008 0:00	8/19/2008 0:00	35.00	Y
	T-014-Se-1	7/15/2008 0:00	7/30/2008 0:00	15.00	Y
	T-014-Se-1-Dup	7/15/2008 0:00	7/30/2008 0:00	15.00	Y
	T-015-Se-1	7/15/2008 0:00	7/30/2008 0:00	15.00	Y
	T-016-Se-1	7/15/2008 0:00	7/30/2008 0:00	15.00	Y
	ERS-Se-1	7/12/2008 0:00	7/30/2008 0:00	18.00	Y
	Trip1-Se-1-SI	7/14/2008 0:00	7/30/2008 0:00	16.00	Y
A877902	T-001-Se-1	7/10/2008 0:00	8/19/2008 0:00	40.00	Y
	T-001-Se-1-Dup	7/10/2008 0:00	8/19/2008 0:00	40.00	Y
	T-002-Se-1	7/10/2008 0:00	8/19/2008 0:00	40.00	Y
	T-003-Se-1	7/11/2008 0:00	8/19/2008 0:00	39.00	Y
	W-007-Se-1-C	7/11/2008 0:00	8/19/2008 0:00	39.00	Y
	W-007-Se-1-D	7/11/2008 0:00	8/19/2008 0:00	39.00	Y
	W-007-Se-1-E	7/11/2008 0:00	8/19/2008 0:00	39.00	Y
	W-008-Se-1	7/12/2008 0:00	8/19/2008 0:00	38.00	Y
	W-007-Se-1-A	7/11/2008 0:00	8/19/2008 0:00	39.00	Y
	W-001-Se-1	7/11/2008 0:00	8/19/2008 0:00	39.00	Y
	W-002-Se-1	7/11/2008 0:00	8/19/2008 0:00	39.00	Y
	W-002-Se-1-Dup	7/11/2008 0:00	8/19/2008 0:00	39.00	Y

SDG	Sample ID	Sample Collected Date/Time	Sample Analyzed Date/Time	Holding Time (Days)	Meet DQO for Holding Time *
	W-003-Se-1	7/11/2008 0:00	8/19/2008 0:00	39.00	Y
	W-004-Se-1	7/11/2008 0:00	8/19/2008 0:00	39.00	Y
	W-005-Se-1	7/11/2008 0:00	8/19/2008 0:00	39.00	Y
A877902	T004-SE-1	7/11/2008 0:00	9/17/2008 0:00	68.00	Y
	T005-SE-1	7/10/2008 0:00	9/17/2008 0:00	69.00	Y
	T006-SE-1	7/10/2008 0:00	9/17/2008 0:00	69.00	Y
	T007-SE-1	7/10/2008 0:00	9/17/2008 0:00	69.00	Y
	T008-SE-1	7/10/2008 0:00	9/17/2008 0:00	69.00	Y
	T009-SE-1	7/13/2008 0:00	9/17/2008 0:00	66.00	Y
	W007-SE-1	7/11/2008 0:00	9/17/2008 0:00	68.00	Y
A877812	E008-SE-1	7/9/2008 0:00	9/12/2008 0:00	65.00	Y
	E009-SE-1	7/9/2008 0:00	9/13/2008 0:00	66.00	Y
	E010-SE-1	7/9/2008 0:00	9/13/2008 0:00	66.00	Y
	E011-SE-1	7/9/2008 0:00	9/13/2008 0:00	66.00	Y
	E011-SE-1- DUP	7/9/2008 0:00	9/13/2008 0:00	66.00	Y
	E012-SE-1	7/13/2008 0:00	9/13/2008 0:00	62.00	Y
	E013-SE-1	7/13/2008 0:00	9/13/2008 0:00	62.00	Y
	E014-SE-1	7/13/2008 0:00	9/13/2008 0:00	62.00	Y
	E015-SE-1	7/13/2008 0:00	9/12/2008 0:00	61.00	Y
	E013-SE-1-A	7/13/2008 0:00	9/14/2008 0:00	63.00	Y
	E013-SE-1-A-DUP	7/13/2008 0:00	9/14/2008 0:00	63.00	Y
	E013-SE-1-B-DUP	7/13/2008 0:00	9/14/2008 0:00	63.00	Y
	E013-SE-1-B	7/13/2008 0:00	9/14/2008 0:00	63.00	Y
	E013-SE-1-C	7/13/2008 0:00	9/14/2008 0:00	63.00	Y
	E013-SE-1-D	7/13/2008 0:00	9/15/2008 0:00	64.00	Y
	E013-SE-1-E	7/13/2008 0:00	9/14/2008 0:00	63.00	Y
	T009-SE-1-DUP	7/13/2008 0:00	9/16/2008 0:00	65.00	Y
	T010-SE-1	7/13/2008 0:00	9/15/2008 0:00	64.00	Y
	T011-SE-1	7/13/2008 0:00	9/17/2008 0:00	66.00	Y
	T012-SE-1	7/13/2008 0:00	9/16/2008 0:00	65.00	Y
	E001-SE-1	7/8/2008 0:00	9/16/2008 0:00	70.00	Y
	E002-SE-1	7/8/2008 0:00	9/16/2008 0:00	70.00	Y
	E003-SE-1	7/8/2008 0:00	9/17/2008 0:00	71.00	Y
	E004-SE-1	7/8/2008 0:00	9/16/2008 0:00	70.00	Y
	E005-SE-1	7/8/2008 0:00	9/16/2008 0:00	70.00	Y
	E006-SE-1	7/9/2008 0:00	9/16/2008 0:00	69.00	Y
	E007-SE-1	7/9/2008 0:00	9/16/2008 0:00	69.00	Y

SDG	Sample ID	Sample Collected Date/Time	Sample Analyzed Date/Time	Holding Time (Days)	Meet DQO for Holding Time *
A884606	Trip2-Se-1-SI	7/29/2008 0:00	9/21/2008 0:00	54.00	Y
A877902	W006-SE-1	7/11/2008 0:00	9/21/2008 0:00	72.00	Y
	W007-SE-1-B	7/11/2008 0:00	9/21/2008 0:00	72.00	Y

Accuracy

Accuracy was evaluated using the %R results for the blank spike samples (BS), Limit of Quantification (LOQ) samples, and labeled compound spikes.

The BS, LOQ and labeled compound spike recoveries %Rs were within method acceptance criteria, except for the congeners listed in "PCB_QC_Sed and Water_UH" worksheet "PCB Sed Flags". All LOQ failures are flagged "Q", blank spike failures are flagged "S" and labeled compound spike recovery failures are flagged "R". All associated congeners are flagged according to the QC failure type.

Precision

Precision was evaluated using the Relative Percent Difference (%RPD) obtained from the parent sample/field duplicate sample results. The following samples were collected and analyzed in duplicate for field duplicate QC purposes: 11193-SE-1 (collected 5/2/08), 15301-SE-1 (collected 6/2/08), 11258-SE-1 (collected 6/2/08), T-014-SE-1 (collected 7/15/08), T-001-SE-1 (collected 7/10/08), W-002-SE-1 (collected 7/11/08), E-011-SE-1 (collected 7/9/08), E013-SE-1-A (collected 7/13/08), E013-SE-1-B (collected 7/13/08), and T009-SE-1 (collected 7/13/08).

All field duplicate results were within QAPP tolerance except for the congeners listed in "PCB_QC_Sed and Water_UH" worksheet "PCB Sed Flags". Both the parent and field duplicate samples were flagged "F" as estimated due to the out of tolerance % RPD. All associated congeners, that weren't previously flagged "J", "B" or "U" by the lab, were flagged as estimated ("F") by the data verifier.

The following samples were analyzed in duplicate for lab duplicate QC purposes: 13338-SE-1, 11262-SE-1, C004-SE-1A, W001-SE-1, E014-SE-1, T009-SE-1. All lab duplicate results were within QAPP tolerance.

Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents actual site conditions. Representativeness has been evaluated by:

* Comparing the chain-of-custody procedures to those described in the QAPP;
* Evaluating holding times; and

* Examining method blanks for contamination of samples during analysis.

The samples in this SDG were collected and analyzed following the QAPP, COC and analytical procedures. All samples were prepared and analyzed with the holding times required for the analysis.

All initial calibration criteria were met.

All continuing calibration criteria (BS) were met, with the exception of those listed in the accuracy table.

All LOQ standard criteria were met, with the exception of those listed in the accuracy table.

There was at least one method blank analyzed with each batch associated with the PCBs analyses in each SDG. The method blanks had many PCBs of concern above the RLs. The sample results that were less than five (5) times the amount found in the blank were "B" flagged for having blank contamination.

Completeness

Completeness has been evaluated by comparing the total number of samples collected with the total number of samples with valid analytical data.

No reported results for samples in this SDG have been rejected or invalidated. The completeness for this SDG is 100% compared to the minimum acceptance limit of 90%.

Flag Key:
H = Holding time exceedance
I = Ion ration failure
F = Field dup exceedance
L = Lab dup exceedance
S = Blank spike or lab control spike exceedance
Q = Limit of Quantitation (LOQ) exceedance
R = Surrogate/Internal Standard exceedance
J = Estimated by lab
U = Non-detected above MDL
B = Blank Contamination

TOTAL ORGANIC CARBON

General

The SDGs included in this report contained the samples listed in Table 1 and analyzed for TOC. The TOC analyses were performed using LECO Combustion Method (lab method: CAM SOP-00468). All samples for this SDG were collected and analyzed following the procedures and protocols outlined in the QAPP. All samples collected were prepared and analyzed within the holding times required by the method, with the exception of 13338 (collected 4/24/08).

Table 1: Data Packages, Sample IDs and Collection Dates and Times

SDG	Sample ID	Sample Collected Date/Time	Sample Analyzed Date/Time	Holding Time (Days)	Meet DQO for Holding Time *
A845781	13338-SE-1	4/24/2008 0:00	5/24/2008 0:00	30.00	N
	11287-SE-1	4/28/2008 0:00	5/24/2008 0:00	26.00	Y
	11274-SE-1	4/28/2008 0:00	5/24/2008 0:00	26.00	Y
	11270-SE-1	4/29/2008 0:00	5/24/2008 0:00	25.00	Y
	15979-SE-1	4/30/2008 0:00	5/24/2008 0:00	24.00	Y
	16622-SE-1	5/1/2008 0:00	5/24/2008 0:00	23.00	Y
	11280-SE-1	4/30/2008 0:00	5/24/2008 0:00	24.00	Y
	11264-SE-1	5/2/2008 0:00	5/24/2008 0:00	22.00	Y
	11193-SE-1-Dup	5/2/2008 0:00	5/24/2008 0:00	22.00	Y
	11193-SE-1	5/2/2008 0:00	5/24/2008 0:00	22.00	Y
A855832	16213-SE-1-SOIL	5/27/2008 0:00	6/11/2008 0:00	15.00	Y
	11252-SE-1-SOIL	5/27/2008 0:00	6/11/2008 0:00	15.00	Y
	14560-SE-1-SOIL	5/27/2008 0:00	6/11/2008 0:00	15.00	Y
	13363-SE-1-SOIL	5/27/2008 0:00	6/11/2008 0:00	15.00	Y
	16499-SE-1-SOIL	5/27/2008 0:00	6/11/2008 0:00	15.00	Y
	16618-SE-1-SOIL	5/29/2008 0:00	6/11/2008 0:00	13.00	Y
	13355-SE-1-SOIL	5/29/2008 0:00	6/11/2008 0:00	13.00	Y
A860731	13342-SE-1-SOIL	6/4/2008 0:00	6/17/2008 0:00	13.00	Y
	11262-SE-1-SOIL	6/4/2008 0:00	6/17/2008 0:00	13.00	Y
	11261-SE-1-SOIL	6/4/2008 0:00	6/17/2008 0:00	13.00	Y
	11132-SE-1-SOIL	6/4/2008 0:00	6/17/2008 0:00	13.00	Y
	TRIP1-SE-1-SOIL	6/4/2008 0:00	6/17/2008 0:00	13.00	Y
	TRIP2-SE-1-SOIL	6/4/2008 0:00	6/17/2008 0:00	13.00	Y
	11258-SE-1-SOIL	6/2/2008 0:00	6/17/2008 0:00	15.00	Y
	15301-SE-1-DUP-SOIL	6/2/2008 0:00	6/17/2008 0:00	15.00	Y
	15301-SE-1-SOIL	6/2/2008 0:00	6/17/2008 0:00	15.00	Y
	13344-SE-1-SOIL	6/2/2008 0:00	6/17/2008 0:00	15.00	Y
	11347-SE-1-SOIL	6/2/2008 0:00	6/17/2008 0:00	15.00	Y

SDG	Sample ID	Sample Collected Date/Time	Sample Analyzed Date/Time	Holding Time (Days)	Meet DQO for Holding Time *
A861230	11292-SE-1	6/2/2008 0:00	6/17/2008 0:00	15.00	Y
	11258-SE-1-DUP	6/2/2008 0:00	6/17/2008 0:00	15.00	Y
A877812	T009-SE-1-DUP-SOIL	7/13/2008 0:00	7/30/2008 0:00	17.00	Y
	T010-SE-1-SOIL	7/13/2008 0:00	7/30/2008 0:00	17.00	Y
	T011-SE-1-SOIL	7/13/2008 0:00	7/30/2008 0:00	17.00	Y
	T012-SE-1-SOIL	7/13/2008 0:00	7/30/2008 0:00	17.00	Y
	E001-SE-1-SOIL	7/8/2008 0:00	7/30/2008 0:00	22.00	Y
	E002-SE-1-SOIL	7/8/2008 0:00	7/30/2008 0:00	22.00	Y
	E003-SE-1-SOIL	7/8/2008 0:00	7/30/2008 0:00	22.00	Y
	E004-SE-1-SOIL	7/8/2008 0:00	7/30/2008 0:00	22.00	Y
	E005-SE-1-SOIL	7/8/2008 0:00	7/30/2008 0:00	22.00	Y
	E006-SE-1-SOIL	7/9/2008 0:00	7/30/2008 0:00	21.00	Y
	E007-SE-1-SOIL	7/9/2008 0:00	7/30/2008 0:00	21.00	Y
	E008-SE-1-SOIL	7/9/2008 0:00	7/30/2008 0:00	21.00	Y
	E009-SE-1-SOIL	7/9/2008 0:00	7/30/2008 0:00	21.00	Y
	E010-SE-1-SOIL	7/9/2008 0:00	7/30/2008 0:00	21.00	Y
	E011-SE-1-SOIL	7/9/2008 0:00	7/30/2008 0:00	21.00	Y
	E011-SE-1-SOIL-DUP	7/9/2008 0:00	7/30/2008 0:00	21.00	Y
	E012-SE-1-SOIL	7/13/2008 0:00	7/30/2008 0:00	17.00	Y
	E013-SE-1-SOIL	7/13/2008 0:00	7/30/2008 0:00	17.00	Y
	E014-SE-1-SOIL	7/13/2008 0:00	7/30/2008 0:00	17.00	Y
	E015-SE-1-SOIL	7/13/2008 0:00	7/30/2008 0:00	17.00	Y
	E013-SE-1-A-SOIL	7/13/2008 0:00	7/29/2008 0:00	16.00	Y
	E013-SE-1-A-DUP-SOIL	7/13/2008 0:00	7/29/2008 0:00	16.00	Y
	E013-SE-1-B-SOIL	7/13/2008 0:00	7/29/2008 0:00	16.00	Y
	E013-SE-1-B-DUP-SOIL	7/13/2008 0:00	7/29/2008 0:00	16.00	Y
	E013-SE-1-C-SOIL	7/13/2008 0:00	7/29/2008 0:00	16.00	Y
	E013-SE-1-D-SOIL	7/13/2008 0:00	7/29/2008 0:00	16.00	Y
	E013-SE-1-E-SOIL	7/13/2008 0:00	7/29/2008 0:00	16.00	Y
A877854	C001-SE-1-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	C002-SE-1-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	C003-SE-1-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	C004-SE-1-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	C005-SE-1-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	C006-SE-1-SOIL	7/13/2008 0:00	8/6/2008 0:00	24.00	Y
	C004-SE-1-A-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	C004-SE-1-B-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	C004-SE-1-C-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	C004-SE-1-D-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	C004-SE-1-E-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	ERS-SE-1-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	T014-SE-1-SOIL	7/15/2008 0:00	8/6/2008 0:00	22.00	Y

SDG	Sample ID	Sample Collected Date/Time	Sample Analyzed Date/Time	Holding Time (Days)	Meet DQO for Holding Time *
	T016-SE-1-SOIL	7/15/2008 0:00	8/6/2008 0:00	22.00	Y
	T014-SE-1-DUP-SOIL	7/15/2008 0:00	8/6/2008 0:00	22.00	Y
	TRIP1-SE-1-SOIL	7/14/2008 0:00	8/6/2008 0:00	23.00	Y
	T015-SE-1-SOIL	7/15/2008 0:00	8/6/2008 0:00	22.00	Y
	T013-SE-1-SOIL	7/15/2008 0:00	8/6/2008 0:00	22.00	Y
A877902	W007-SE-1-B-SOIL	7/11/2008 0:00	8/7/2008 0:00	27.00	Y
	W007-SE-1-C-SOIL	7/11/2008 0:00	8/7/2008 0:00	27.00	Y
	W007-SE-1-D-SOIL	7/11/2008 0:00	8/7/2008 0:00	27.00	Y
	T008-SE-1-SOIL	7/10/2008 0:00	8/7/2008 0:00	28.00	Y
	T009-SE-1-SOIL	7/13/2008 0:00	8/7/2008 0:00	25.00	Y
	W007-SE-1-SOIL	7/11/2008 0:00	8/7/2008 0:00	27.00	Y
	W001-SE-1-SOIL	7/11/2008 0:00	8/6/2008 0:00	26.00	Y
	W002-SE-1-SOIL	7/11/2008 0:00	8/6/2008 0:00	26.00	Y
	W002-SE-1-DUP-SOIL	7/11/2008 0:00	8/6/2008 0:00	26.00	Y
	W003-SE-1-SOIL	7/11/2008 0:00	8/6/2008 0:00	26.00	Y
	W004-SE-1-SOIL	7/11/2008 0:00	8/6/2008 0:00	26.00	Y
	W005-SE-1-SOIL	7/11/2008 0:00	8/6/2008 0:00	26.00	Y
	W006-SE-1-SOIL	7/11/2008 0:00	8/6/2008 0:00	26.00	Y
	W007-SE-1-A-SOIL	7/11/2008 0:00	8/6/2008 0:00	26.00	Y
	W007-SE-1-E-SOIL	7/11/2008 0:00	8/6/2008 0:00	26.00	Y
	W008-SE-1-SOIL	7/12/2008 0:00	8/6/2008 0:00	25.00	Y
	T001-SE-1-SOIL	7/10/2008 0:00	8/6/2008 0:00	27.00	Y
	T001-SE-1-DUP-SOIL	7/10/2008 0:00	8/6/2008 0:00	27.00	Y
	T002-SE-1-SOIL	7/10/2008 0:00	8/6/2008 0:00	27.00	Y
	T003-SE-1-SOIL	7/11/2008 0:00	8/6/2008 0:00	26.00	Y
	T004-SE-1-SOIL	7/11/2008 0:00	8/6/2008 0:00	26.00	Y
	T005-SE-1-SOIL	7/10/2008 0:00	8/6/2008 0:00	27.00	Y
	T006-SE-1-SOIL	7/10/2008 0:00	8/6/2008 0:00	27.00	Y
	T007-SE-1-SOIL	7/10/2008 0:00	8/6/2008 0:00	27.00	Y
A884606	TRIP2-SE-1 - SOIL	7/29/2008 0:00	8/21/2008 0:00	23.00	Y

Sample 13338 (collected 4/24/08) was analyzed 2 day outside of holding time. This sample was flagged "H" for the minor exceedances of holding time for TOC.

Accuracy

Accuracy was evaluated using the %R results for the blank spike samples (BS). The BS %Rs were within method acceptance criteria for all SDGs.

Precision

Precision was evaluated using the Relative Percent Difference (%RPD) obtained from the parent sample/field duplicate sample results and the lab duplicate results. The following samples were collected and analyzed in duplicate for field duplicate QC purposes: 11193-SE-1 (collected 5/2/08), 15301-SE-1 (collected 6/2/08), 11258-SE-1 (collected 6/2/08), T-014-SE-1 (collected 7/15/08), T-001-SE-1 (collected 7/10/08), W-002-SE-1 (collected 7/11/08), E-011-SE-1 (collected 7/9/08), E013-SE-1-A (collected 7/13/08), E013-SE-1-B (collected 7/13/08), and T009-SE-1 (collected 7/13/08). All field duplicate results were within QAPP tolerance, except for the following:

Field Duplicate Results for TOC Samples							
SDG	Lab Batch #	Sample ID	Sample Date	TOC (mg/Kg)		RPD	Accept
				T1	T2		
A860731 & A861230	1538383	11258-SE-1-DUP	6/2/2008	9400	5100	59.3	N

Samples 11258-SE-1 and 11258-SE-1-Dup were flagged "F" for field duplicate % RPD exceedances.

The following samples were analyzed in duplicate for lab duplicate QC purposes: 13338-SE-1, 16213-SE-1, 13342-SE-1, 11258-SE-1-DUP, E005-SE-1, E013-SE-1-B, C001-SE-1, W001-SE-1, and TRIP2-SE-1.

All lab duplicate results were within QAPP tolerance, with the following exception:

Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents actual site conditions. Representativeness has been evaluated by:

* Comparing the chain-of-custody procedures to those described in the QAPP;
* Evaluating holding times; and
* Examining method blanks for contamination of samples during analysis.

The samples in this SDG were collected and analyzed following the QAPP, COC and analytical procedures. All samples were prepared and analyzed with the holding times required for the analysis.

All initial calibration criteria were met.

All continuing calibration criteria (BS) were met, with the exception of those listed in the accuracy table.

There was at least one method blank analyzed with each batch associated with the TOC analyses in each SDG. The method blanks were below the RLs.

Completeness

Completeness has been evaluated by comparing the total number of samples collected with the total number of samples with valid analytical data.

No reported results for samples in this SDG have been rejected or invalidated. The completeness for this SDG is 100% compared to the minimum acceptance limit of 90%.

Flag Key:
H = Holding time exceedance
I = Ion ration failure
F = Field dup exceedance
L = Lab dup exceedance
S = Blank spike or lab control spike exceedance
Q = Limit of Quantitation (LOQ) exceedance
R = Surrogate/Internal Standard exceedance
J = Estimated by lab
U = Non-detected above MDL
B = Blank Contamination

DATA VERIFICATION SUMMARY REPORT

FOR PCBS IN SEDIMENT SAMPLES COLLECTED IN THE

HOUSTON SHIP CHANNEL SYSTEM

(Segments 0901, 1001, 1005, 1006, 1007, 2420, 2429,

2428, 2427, 2426, 2436, 2438, and 2421)

HOUSTON, TEXAS

Data Verifier: Sandra de las Fuentes (Parsons - Austin, TX)

INTRODUCTION

The following data verification summary report covers analysis of environmental sediment samples, including forty-two (42) sediment samples and four (4) field duplicate samples, collected from the Houston Ship Channel System in Houston Texas over the three month period between May 6, 2009 and August 12, 2009. The samples were analyzed for Polychlorinated Biphenyls (PCBs) as congeners following laboratory Sample Delivery Groups (SDGs)

1094733, 1096016, 1096018, 1097888, 1097891, 1097894, 1097895, 1098517, 1099535, and 10110354.

All samples were collected by the University of Houston and Parsons following the procedures described in the QAPP. All analyses were performed by Pace Analytical Services, Inc. in Minneapolis, Minnesota, following procedures outlined in the QAPP and Method 1668A for PCB congeners.

EVALUATION CRITERIA

The data submitted by the laboratory has been reviewed and verified following the guidelines outlined in the QAPP and National Functional Guidelines for Organic and Inorganic Data (EPA 1994). Information reviewed in the data packages include sample results; the laboratory quality control results; instrument calibrations; blanks; case narrative and chain-of-custody forms. The verification protocol addressed the following parameters: method blanks, laboratory control spike recoveries, recoveries of labeled compounds (internal standards), continuing calibration verifications, laboratory and field duplicate sample percent reproducibility (%RPD), percent recovery (%R), and Level of Quantification (LOQ) standard results. The analyses and findings presented in this report are based on the reviewed information, and meeting guidelines in the QAPP (with the exceptions noted below).

POLYCHLORINATED BIPHENYLS

General

The SDGs included in this report contained the samples listed in Table 1 and analyzed for PCBs. The PCBs analyses were performed using USEPA Method 1668A. All samples for this SDG were collected and analyzed following the procedures and protocols outlined in the QAPP. All samples collected were prepared and analyzed within the holding times required by the method. Some sediment samples required dilution due to high PCBs and/or matrix interference.

Table 1: Data Packages, Sample IDs and Collection Dates and Times

					Meet DQO for Holding Time *
1094733	13338-SE-2	5/6/2009	6/19/2009	44	Y
	13338-SE-2-DUP	5/6/2009	6/19/2009	44	Y
	16499-SE-2	5/6/2009	6/19/2009	44	Y
	11252-SE-2	5/6/2009	6/19/2009	44	Y
1096016	11258-SE-2	5/22/2009	6/18/2009	27	Y
	15301-SE-2	5/26/2009	6/18/2009	23	Y
	11270-SE-2-DUP	5/26/2009	6/18/2009	23	Y
	11193-SE-2	5/20/2009	6/22/2009	33	Y
	13344-SE-2	5/20/2009	6/21/2009	32	Y
	11261-SE-2	5/20/2009	6/18/2009	29	Y
	16618-SE-2	5/21/2009	6/19/2009	29	Y
	15936-SE-2	5/26/2009	6/18/2009	23	Y
1096018	16622-SE-2	5/21/2009	6/17/2009	27	Y
	11270-SE-2	5/26/2009	6/18/2009	23	Y
	15979-SE-2	5/26/2009	6/18/2009	23	Y
1097888	11264-SE-2	5/29/2009	7/1/2009	33	Y
	11280-SE-2	5/29/2009	07/10/2009	42	Y
	11274-SE-2	6/4/2009	07/01/2009	27	Y
	11292-SE-2	6/4/2009	07/01/2009	27	Y
	11287-SE-2	6/4/2009	07/10/2009	36	Y
	11287-SE-2-DUP	6/4/2009	07/10/2009	36	Y
	11262-SE-2	6/4/2009	07/01/2009	27	Y
1097891	TBD11-SE-2	6/10/2009	07/07/2009	27	Y
	TRIP1-SED-2	6/10/2009	07/07/2009	27	Y
1097894	11132-SE-2	6/17/2009	07/13/2009	26	Y
	18322-SE-2	6/18/2009	07/13/2009	25	Y
	11265-SE-2	6/12/2009	07/13/2009	31	Y
	11285-SE-2	6/12/2009	07/13/2009	31	Y
	ERB1-SE-2	6/18/2009	07/13/2009	25	Y
	11288-SE-2	6/12/2009	07/13/2009	31	Y
	11302-SE-2	6/10/2009	07/14/2009	34	Y

					Meet DQO for Holding Time *
1097895	TBD10-SE-2	6/12/2009	07/07/2009	25	Y
	18322-SE-2-DUP	6/18/2009	07/07/2009	19	Y
	TRIP2-SE-2	6/18/2009	7/8/2009	20	Y
1098517	11347-SE-2	6/29/2009	7/14/2009	15	Y
	11129-SE-2	6/26/2009	7/21/2009	25	Y
	20574-SE-2	6/26/2009	7/15/2009	19	Y
1099535	13342-Se-2	5/20/2009	09/04/2009	107	Y
	T002-Se-2	6/11/2009	09/04/2009	85	Y
	17149-Se-2	7/15/2009	09/04/2009	51	Y
10110354	18363-SE-2	8/10/2009	09/02/2009	23	Y
	TBD15-SE-2	8/12/2009	09/02/2009	21	Y

* Holding time acceptance criteria for PCBs is less than 1 yr.

Accuracy

Accuracy was evaluated using the %R results for the blank spike samples (BS), Limit of Quantification (LOQ) samples, and labeled compound spikes.

The BS, LOQ and labeled compound spike recoveries %Rs were within method acceptance criteria, except for the congeners listed in "PCB_QC_Sed_Pace_UH_2009(P2)" worksheet "PCB Sed Flags". All LOQ failures are flagged "Q", blank spike failures are flagged "S" and labeled compound spike recovery failures are flagged "R". All associated congeners are flagged according to the QC failure type.

Precision

Precision was evaluated using the Relative Percent Difference (%RPD) obtained from the parent sample/field duplicate sample results. The following samples were collected and analyzed in duplicate for field duplicate QC purposes: 13338-SE-2 (collected 5/6/09), 11270-SE-2 (collected 5/26/09), 11287-SE-2 (collected 6/4/09), and 18322-SE-2 (collected 6/18/09).

All field duplicate results were within QAPP tolerance except for the congeners listed in "PCB_QC_Sed_Pace_UH_2009(P2)" worksheet "PCB Sed Flags". Both the parent and field duplicate samples were flagged "F" as estimated due to the out of tolerance % RPD. All associated congeners, that weren't previously flagged "J", "B" or "U" by the lab, were flagged as estimated ("F") by the data verifier.

The following sample was analyzed in duplicate for lab duplicate QC purposes: 15301-SE-2 (analyzed 6/18/09 in SDG 1096016). All lab duplicate results were within QAPP tolerance.

The overall frequency of LD and FD is as follows:

QC Frequency for PCB Sediment Samples						
						Frequency of LD
1094733	3	1	4	0	33.3%	0.0%
1096018	3	0	3	0	0.0%	0.0%
1096016	7	1	8	1	14.3%	12.5%
1097888	6	1	7	0	16.7%	0.0%
1097895	2	1	3	0	50.0%	0.0%
1097891	2	0	2	0	0.0%	0.0%
1097894	7	0	7	0	0.0%	0.0%
1098517	3	0	3	0	0.0%	0.0%
1099535	3	0	3	0	0.0%	0.0%
10110354	2	0	2	0	0.0%	0.0%
			Overall Frequency		**10.5%**	**2.4%**

The overall frequency met the required criteria for FDs and LDs of 5%. Laboratory duplicates were rarely possible for these matrices due to insufficient media. An “F” flag was applied to the parent and FD congeners that were greater than 50% RPD. All lab duplicate RPDs with results above the RL were within the 40% criteria. No flags were required.

Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents actual site conditions. Representativeness has been evaluated by:

* Comparing the chain-of-custody procedures to those described in the QAPP;
* Evaluating holding times; and
* Examining method blanks for contamination of samples during analysis.

The samples in this SDG were collected and analyzed following the QAPP, COC and analytical procedures. All samples were prepared and analyzed with the holding times required for the analysis.

All initial calibration criteria were met.

All continuing calibration criteria (BS) were met, with the exception of those listed in the accuracy table.

All LOQ standard criteria were met, with the exception of those listed in “PCB_QC_Sed_Pace_UH_2009(P2)” worksheet “PCB Sed Flags”.

There was at least one method blank analyzed with each batch associated with the PCBs analyses in each SDG. The method blanks had many PCBs of concern above the RLs. The sample results that were less than five (5) times the amount found in the blank were “B” flagged for having blank contamination.

Completeness

Completeness has been evaluated by comparing the total number of samples collected with the total number of samples with valid analytical data.

No reported results for samples in this SDG have been rejected or invalidated. The completeness for this SDG is 100% compared to the minimum acceptance limit of 90%.

COMPARABILITY

All data was generated using contract-specific standard methods and reported with known data quality, type of analysis, units, etc.

DATA USABILITY

All calculations were spot checked and verified. All data in this SDG are considered usable for the purposes of this project.

APPENDIX B
HISTORICAL FISH TISSUE DATA

INTRODUCTION

In response to a request by USEPA in comments on the draft Preliminary Site Characterization Report, Table B-1 presents historical fish tissue data from three separate fish tissue studies. Those samples collected prior to 2006 are listed. These data are not included in the baseline dataset.

The studies are as follows:

ENSR and EHA, 1995. Houston Ship Channel Toxicity Study. Prepared for the City of Houston, Houston, TX. ENSR Consulting and Engineering, Houston, TX and Espey, Huston and Associates, Austin, TX.

TDSHS, 2010. Texas Fish Tissue Data. Collection of Excel files sent to Jennifer Sampson (Integral) from Michael Tennant (TDSHS) on 1/20/2010 containing tables of fish tissue chemical data collected over several decades from the Galveston Bay area. Texas Department of State Health Services.

University of Houston and Parsons, 2006. Total Maximum Daily Loads for Dioxins in the Houston Ship Channel. Contract No. 582-6-70860, Work Order No. 582-6-70860-02. Quarterly report No. 3. Prepared in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency. University of Houston and Parsons Water & Infrastructure. Available at: http://www.tceq.state.tx.us/assets/public/implementation/water/tmdl/26hscdioxin/26-all-data-compiled-q3-fy06.pdf.

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
ENSR and EHA (1995)	7	HSC-TS-007B-156A,1	10/1/1993	Blue catfish	Fillet	1.66	
ENSR and EHA (1995)	9	HSC-TS-009-11	10/1/1993	Blue catfish	Fillet	2.31	
ENSR and EHA (1995)	10	HSC-TS-010-13	10/1/1993	Blue catfish	Fillet	0.0181	
ENSR and EHA (1995)	1	HSC-CT-001	10/1/1993	Blue crab	Edible	2.19	
ENSR and EHA (1995)	7	HSC-CT-007	10/1/1993	Blue crab	Edible	5.47	
ENSR and EHA (1995)	9	HSC-CT-009	10/1/1993	Blue crab	Edible	2.47	
ENSR and EHA (1995)	10	HSC-CT-10	10/1/1993	Blue crab	Edible	0.973	
ENSR and EHA (1995)	16	HSC-CT-016	10/1/1993	Blue crab	Edible	0.14	
ENSR and EHA (1995)	17	HSC-CT-017	10/1/1993	Blue crab	Edible	3.46	
TDSHS (2010)	TDSHS_FishLoc82	20040219bcfHSC28	2/19/2004	Blue catfish	Fillet	0.246	
TDSHS (2010)	TDSHS_FishLoc82	20040219bcfHSC29	2/19/2004	Blue catfish	Fillet	0.211	
TDSHS (2010)	TDSHS_FishLoc83	20040210bcfHSC10	2/10/2004	Blue catfish	Fillet	5.43	
TDSHS (2010)	TDSHS_FishLoc83	20040210bcfHSC7	2/10/2004	Blue catfish	Fillet	3.2	
TDSHS (2010)	TDSHS_FishLoc83	20040210bcfHSC9	2/10/2004	Blue catfish	Fillet	7.16	
TDSHS (2010)	TDSHS_FishLoc84	20040210bcfHSC1	2/10/2004	Blue catfish	Fillet	1.5	
TDSHS (2010)	TDSHS_FishLoc84	20040211bcfHSC2	2/11/2004	Blue catfish	Fillet	5.78	
TDSHS (2010)	TDSHS_FishLoc84	20040311bcfHSC4	3/11/2004	Blue catfish	Fillet	0.97	
TDSHS (2010)	TDSHS_FishLoc85	20040311bcfHSC40	3/11/2004	Blue catfish	Fillet	3	
TDSHS (2010)	TDSHS_FishLoc85	20040311bcfHSC41	3/11/2004	Blue catfish	Fillet	8.86	
TDSHS (2010)	TDSHS_FishLoc01	19960411bcbGAL1221	4/11/1996	Blue crab	Edible	0.651	
TDSHS (2010)	TDSHS_FishLoc01	19960411bcbGAL1222	4/11/1996	Blue crab	Edible	2.08	
TDSHS (2010)	TDSHS_FishLoc01	19960411bcbGAL1223	4/11/1996	Blue crab	Edible	1.52	
TDSHS (2010)	TDSHS_FishLoc01	19960411bcbGAL1224	4/11/1996	Blue crab	Edible	0.741	
TDSHS (2010)	TDSHS_FishLoc01	19960411bcbGAL1225	4/11/1996	Blue crab	Edible	1.32	
TDSHS (2010)	TDSHS_FishLoc02	19940609bcbGAL2134	6/9/1994	Blue crab	Edible	1.68	
TDSHS (2010)	TDSHS_FishLoc02	19940609bcbGAL2135	6/9/1994	Blue crab	Edible	1.52	
TDSHS (2010)	TDSHS_FishLoc02	19940609bcbGAL2136	6/9/1994	Blue crab	Edible	2.49	
TDSHS (2010)	TDSHS_FishLoc28	19960411bcbHSC4	4/11/1996	Blue crab	Edible	4.17	
TDSHS (2010)	TDSHS_FishLoc28	19960411bcbHSC5	4/11/1996	Blue crab	Edible	2.62	
TDSHS (2010)	TDSHS_FishLoc28	19960411bcbHSC6	4/11/1996	Blue crab	Edible	5.05	
TDSHS (2010)	TDSHS_FishLoc28	19960411bcbHSC7	4/11/1996	Blue crab	Edible	4.28	

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
TDSHS (2010)	TDSHS_FishLoc28	19960411bcbHSC8	4/11/1996	Blue crab	Edible	4.23	
TDSHS (2010)	TDSHS_FishLoc34	19990615bcbCLC10	6/15/1999	Blue crab	Edible	0.08	
TDSHS (2010)	TDSHS_FishLoc34	19990615bcbCLC8	6/15/1999	Blue crab	Edible	0.0495	
TDSHS (2010)	TDSHS_FishLoc35	19990616bcbCLK8	6/16/1999	Blue crab	Edible	0	U
TDSHS (2010)	TDSHS_FishLoc36	19990615bcbCLK6	6/15/1999	Blue crab	Edible	0.389	
TDSHS (2010)	TDSHS_FishLoc36	19990617bcbCLK20	6/17/1999	Blue crab	Edible	0.522	
TDSHS (2010)	TDSHS_FishLoc36	19990617bcbCLK21	6/17/1999	Blue crab	Edible	0.556	
TDSHS (2010)	TDSHS_FishLoc38	19990818bcbGAL25614	8/18/1999	Blue crab	Edible	0.71	
TDSHS (2010)	TDSHS_FishLoc38	19990818bcbGAL25615	8/18/1999	Blue crab	Edible	0.656	
TDSHS (2010)	TDSHS_FishLoc38	19990825bcbGAL25621	8/25/1999	Blue crab	Edible	0.733	
TDSHS (2010)	TDSHS_FishLoc49	19920416bcbWES513	4/16/1992	Blue crab	Edible	0	U
TDSHS (2010)	TDSHS_FishLoc81	20040218bcbHSC31	2/18/2004	Blue crab	Edible	0.575	
TDSHS (2010)	TDSHS_FishLoc81	20040310bcbHSC35	3/10/2004	Blue crab	Edible	1.75	
TDSHS (2010)	TDSHS_FishLoc82	20040312bcbHSC32	3/12/2004	Blue crab	Edible	2.58	
TDSHS (2010)	TDSHS_FishLoc82	20040312bcbHSC43	3/12/2004	Blue crab	Edible	2.23	
TDSHS (2010)	TDSHS_FishLoc83	20040407bcbHSC47	4/7/2004	Blue crab	Edible	1.05	
TDSHS (2010)	TDSHS_FishLoc83	20040407bcbHSC48	4/7/2004	Blue crab	Edible	1.39	
TDSHS (2010)	TDSHS_FishLoc84	20040312bcbHSC15	3/12/2004	Blue crab	Edible	2.06	
TDSHS (2010)	TDSHS_FishLoc84	20040312bcbHSC44	3/12/2004	Blue crab	Edible	2.41	
TDSHS (2010)	TDSHS_FishLoc85	20040407bcbHSC45	4/7/2004	Blue crab	Edible	3.11	
TDSHS (2010)	TDSHS_FishLoc85	20040407bcbHSC46	4/7/2004	Blue crab	Edible	3.09	
TDSHS (2010)	TDSHS_FishLoc94	19990818bcbGAL3032	8/18/1999	Blue crab	Edible	1.2	
TDSHS (2010)	TDSHS_FishLoc94	19990824bcbGAL3035	8/24/1999	Blue crab	Edible	1.26	
TDSHS (2010)	TDSHS_FishLoc94	19990826bcbGAL3036	8/26/1999	Blue crab	Edible	0.777	
TDSHS (2010)	TDSHS_FishLoc82	20040219hsbHSC30	2/19/2004	Hybrid striped bass	Fillet	1.52	
TDSHS (2010)	TDSHS_FishLoc85	20040311hsbHSC42	3/11/2004	Hybrid striped bass	Fillet	1.51	
TDSHS (2010)	TDSHS_FishLoc27	19960411rdmTAB3	4/11/1996	Red drum	Fillet	0.466	
TDSHS (2010)	TDSHS_FishLoc34	19990615rdmCLC2	6/15/1999	Red drum	Fillet	0.0283	
TDSHS (2010)	TDSHS_FishLoc37	19990617rdmCLK9	6/17/1999	Red drum	Fillet	0.0222	
TDSHS (2010)	TDSHS_FishLoc49	19920416rdmWES511	4/16/1992	Red drum	Fillet	0	U
TDSHS (2010)	TDSHS_FishLoc81	20040218rdmHSC21	2/18/2004	Red drum	Fillet	0.0982	U

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
TDSHS (2010)	TDSHS_FishLoc81	20040218rdmHSC22	2/18/2004	Red drum	Fillet	0.148	
TDSHS (2010)	TDSHS_FishLoc85	20040311rdmHSC38	3/11/2004	Red drum	Fillet	0.0938	U
TDSHS (2010)	TDSHS_FishLoc85	20040311rdmHSC39	3/11/2004	Red drum	Fillet	2.8	
TDSHS (2010)	TDSHS_FishLoc83	20040210sbfHSC5	2/10/2004	Smallmouth buffalo	Fillet	2.18	
TDSHS (2010)	TDSHS_FishLoc83	20040210sbfHSC8	2/10/2004	Smallmouth buffalo	Fillet	0.903	
TDSHS (2010)	TDSHS_FishLoc84	20040312sbfHSC34	3/12/2004	Smallmouth buffalo	Fillet	3.08	
TDSHS (2010)	TDSHS_FishLoc27	19960411sfrTAB4	4/11/1996	Southern flounder	Fillet	0.971	
TDSHS (2010)	TDSHS_FishLoc28	19960508sfrHSC11	5/8/1996	Southern flounder	Fillet	5.82	
TDSHS (2010)	TDSHS_FishLoc33	19990826sfrGAL3047	8/26/1999	Southern flounder	Fillet	0.0331	
TDSHS (2010)	TDSHS_FishLoc33	19990826sfrGAL3049	8/26/1999	Southern flounder	Fillet	0.996	
TDSHS (2010)	TDSHS_FishLoc33	19990826sfrGAL34-0	8/26/1999	Southern flounder	Fillet	0.268	
TDSHS (2010)	TDSHS_FishLoc34	19990615sfrCLC4	6/15/1999	Southern flounder	Fillet	0	U
TDSHS (2010)	TDSHS_FishLoc34	19990615sfrCLC6	6/15/1999	Southern flounder	Fillet	0	U
TDSHS (2010)	TDSHS_FishLoc36	19990617sfrCLK19	6/17/1999	Southern flounder	Fillet	0	U
TDSHS (2010)	TDSHS_FishLoc37	19990617sfrCLK15	6/17/1999	Southern flounder	Fillet	0.0169	
TDSHS (2010)	TDSHS_FishLoc37	19990617sfrCLK17	6/17/1999	Southern flounder	Fillet	0	U
TDSHS (2010)	TDSHS_FishLoc37	19990818sfrCLK28	8/18/1999	Southern flounder	Fillet	0.0234	
TDSHS (2010)	TDSHS_FishLoc37	19990818sfrCLK29	8/18/1999	Southern flounder	Fillet	0	U
TDSHS (2010)	TDSHS_FishLoc37	19990818sfrCLK30	8/18/1999	Southern flounder	Fillet	0	U
TDSHS (2010)	TDSHS_FishLoc38	19990817sfrGAL2562	6/17/1999	Southern flounder	Fillet	0	U
TDSHS (2010)	TDSHS_FishLoc38	19990817sfrGAL2563	6/17/1999	Southern flounder	Fillet	0.591	
TDSHS (2010)	TDSHS_FishLoc38	19990817sfrGAL2564	6/17/1999	Southern flounder	Fillet	0.00863	
TDSHS (2010)	TDSHS_FishLoc38	19990817sfrGAL2565	6/17/1999	Southern flounder	Fillet	0.321	
TDSHS (2010)	TDSHS_FishLoc38	19990817sfrGAL2566	6/17/1999	Southern flounder	Fillet	0.252	
TDSHS (2010)	TDSHS_FishLoc49	19920416sfrWES512	4/16/1992	Southern flounder	Fillet	0	U
TDSHS (2010)	TDSHS_FishLoc81	20040218sfrHSC23	2/18/2004	Southern flounder	Fillet	0.189	U
TDSHS (2010)	TDSHS_FishLoc28	19960411sptHSC3	4/11/1996	Spotted seatrout	Fillet	0.711	
TDSHS (2010)	TDSHS_FishLoc33	19990826sptGAL3042	8/26/1999	Spotted seatrout	Fillet	0.0463	
TDSHS (2010)	TDSHS_FishLoc81	20040218sptHSC19	2/18/2004	Spotted seatrout	Fillet	1.73	
TDSHS (2010)	TDSHS_FishLoc81	20040218sptHSC20	2/18/2004	Spotted seatrout	Fillet	0.183	U
TDSHS (2010)	TDSHS_FishLoc82	20040219sptHSC24	2/19/2004	Spotted seatrout	Fillet	0.199	

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
TDSHS (2010)	TDSHS_FishLoc82	20040219sptHSC25	2/19/2004	Spotted seatrout	Fillet	0.2	
TDSHS (2010)	TDSHS_FishLoc85	20040210sptHSC36	2/10/2004	Spotted seatrout	Fillet	0.344	
TDSHS (2010)	TDSHS_FishLoc85	20040311sptHSC37	3/11/2004	Spotted seatrout	Fillet	0.12	U
TDSHS (2010)	TDSHS_FishLoc94	19990824sptGAL3033	8/24/1999	Spotted seatrout	Fillet	0.334	
TDSHS (2010)	TDSHS_FishLoc94	19990824sptGAL3034	8/24/1999	Spotted seatrout	Fillet	0.0288	
University of Houston and Parsons (2006)	11092	030430bcf11092	4/30/2003	Blue catfish	Edible	1.17	J
University of Houston and Parsons (2006)	11092	030430bcf11092-dup	4/30/2003	Blue catfish	Edible	0.856	J
University of Houston and Parsons (2006)	11092	040427bcf11092	4/27/2004	Blue catfish	Edible	0.703	J
University of Houston and Parsons (2006)	11111	040427bcf11111	4/27/2004	Blue catfish	Edible	0.757	J
University of Houston and Parsons (2006)	11193	021120bcf11193	11/20/2002	Blue catfish	Edible	4.9	J
University of Houston and Parsons (2006)	11193	040323bcf11193	3/23/2004	Blue catfish	Edible	5.17	J
University of Houston and Parsons (2006)	11197	040324bcf11197	3/24/2004	Blue catfish	Edible	1.92	J
University of Houston and Parsons (2006)	11197	040324bcf11197-dup	3/24/2004	Blue catfish	Edible	2.58	J
University of Houston and Parsons (2006)	11200	020903bcf11200	9/3/2002	Blue catfish	Edible	1.03	J
University of Houston and Parsons (2006)	11200	021119bcf11200-1	11/19/2002	Blue catfish	Edible	2.93	J
University of Houston and Parsons (2006)	11200	021121bcf11200-2	11/21/2002	Blue catfish	Edible	0.816	J
University of Houston and Parsons (2006)	11252	041003bcf11252	10/3/2004	Blue catfish	Edible	27.3	J
University of Houston and Parsons (2006)	11265	041026bcf11265	10/26/2004	Blue catfish	Edible	9.5	J
University of Houston and Parsons (2006)	11265	041026bcf11265-dup	10/26/2004	Blue catfish	Edible	10.5	J
University of Houston and Parsons (2006)	11272	020726bcf11272	7/26/2002	Blue catfish	Edible	1.48	
University of Houston and Parsons (2006)	11272	020726bcf11272-dup	7/26/2002	Blue catfish	Edible	3	
University of Houston and Parsons (2006)	11272	030430bcf11272	4/30/2003	Blue catfish	Edible	0.983	J
University of Houston and Parsons (2006)	11272	040415bcf11272A	4/15/2004	Blue catfish	Edible	3.61	J
University of Houston and Parsons (2006)	11272	040415bcf11272Adup	4/15/2004	Blue catfish	Edible	1.72	J
University of Houston and Parsons (2006)	11272	040415bcf11272B	4/15/2004	Blue catfish	Edible	1.74	J
University of Houston and Parsons (2006)	11274	020730bcf11274	7/30/2002	Blue catfish	Edible	4.69	
University of Houston and Parsons (2006)	11274	030501bcf11274	5/1/2003	Blue catfish	Edible	3.66	J
University of Houston and Parsons (2006)	11274	040421bcf11274	4/21/2004	Blue catfish	Edible	7.78	J
University of Houston and Parsons (2006)	11287	020825bcf11287	8/25/2002	Blue catfish	Edible	4	J
University of Houston and Parsons (2006)	11287	030505bcf11287	5/5/2003	Blue catfish	Edible	9.03	J
University of Houston and Parsons (2006)	11287	040402bcf11287	4/2/2004	Blue catfish	Edible	2.35	J

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
University of Houston and Parsons (2006)	11292	020911bcf11292	9/11/2002	Blue catfish	Edible	2.27	J
University of Houston and Parsons (2006)	11292	040403bcf11292	4/3/2004	Blue catfish	Edible	2.73	J
University of Houston and Parsons (2006)	11298	020829bcf11298	8/29/2002	Blue catfish	Edible	0.569	J
University of Houston and Parsons (2006)	11298	030501bcf11298	5/1/2003	Blue catfish	Edible	3.38	J
University of Houston and Parsons (2006)	11298	040422bcf11298	4/22/2004	Blue catfish	Edible	13	J
University of Houston and Parsons (2006)	11300	020906bcf11300	9/6/2002	Blue catfish	Edible	37.5	J
University of Houston and Parsons (2006)	11300	040421bcf11300	4/21/2004	Blue catfish	Edible	19.9	J
University of Houston and Parsons (2006)	11302	020826bcf11302	8/26/2002	Blue catfish	Edible	1.64	J
University of Houston and Parsons (2006)	11302	030501bcf11302	5/1/2003	Blue catfish	Edible	1.23	J
University of Houston and Parsons (2006)	11302	040415bcf11302	4/15/2004	Blue catfish	Edible	2.79	J
University of Houston and Parsons (2006)	11302	040415bcf11302-dup	4/15/2004	Blue catfish	Edible	23.4	J
University of Houston and Parsons (2006)	11305	030503bcf11305	5/3/2003	Blue catfish	Edible	7.09	J
University of Houston and Parsons (2006)	11305	040415bcf11305	4/15/2004	Blue catfish	Edible	3.29	J
University of Houston and Parsons (2006)	11347	020813bcf11347-1	8/13/2002	Blue catfish	Edible	1.72	J
University of Houston and Parsons (2006)	11347	020813bcf11347-2	8/13/2002	Blue catfish	Edible	1.61	J
University of Houston and Parsons (2006)	11347	020813bcf11347-2d	8/13/2002	Blue catfish	Edible	2.3	J
University of Houston and Parsons (2006)	11347	030502bcf11347	5/2/2003	Blue catfish	Edible	3.83	J
University of Houston and Parsons (2006)	11347	040422bcf11347	4/22/2004	Blue catfish	Edible	0.199	J
University of Houston and Parsons (2006)	11382	030502bcf11382	5/2/2003	Blue catfish	Edible	1.56	J
University of Houston and Parsons (2006)	11382	030502bcf11382-dup	5/2/2003	Blue catfish	Edible	3.41	J
University of Houston and Parsons (2006)	13340	041005bcf13340	10/5/2004	Blue catfish	Edible	0.977	J
University of Houston and Parsons (2006)	13342	041029bcf13342	10/29/2004	Blue catfish	Edible	13.9	J
University of Houston and Parsons (2006)	16622	020904bcf16622	9/4/2002	Blue catfish	Edible	4.11	J
University of Houston and Parsons (2006)	16622	030530bcf16622	5/30/2003	Blue catfish	Edible	0.894	J
University of Houston and Parsons (2006)	11092	020802bcb11092	8/2/2002	Blue crab	Edible	0.931	J
University of Houston and Parsons (2006)	11092	030429bcb11092	4/29/2003	Blue crab	Edible	0.643	J
University of Houston and Parsons (2006)	11092	030429bcb11092-dup	4/29/2003	Blue crab	Edible	0.435	J
University of Houston and Parsons (2006)	11092	040430bcb11092	4/30/2004	Blue crab	Edible	0.411	J
University of Houston and Parsons (2006)	11111	020731bcb11111	7/31/2002	Blue crab	Edible	1.14	J
University of Houston and Parsons (2006)	11111	030501bcb11111	5/1/2003	Blue crab	Edible	0.858	J
University of Houston and Parsons (2006)	11111	030501bcb11111-dup	5/1/2003	Blue crab	Edible	1.16	J

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
University of Houston and Parsons (2006)	11111	040427bcb11111	4/27/2004	Blue crab	Edible	0.832	J
University of Houston and Parsons (2006)	11193	020809bcb11193	8/9/2002	Blue crab	Edible	5.49	J
University of Houston and Parsons (2006)	11193	021021bcb11193	10/21/2002	Blue crab	Edible	1.44	J
University of Houston and Parsons (2006)	11193	030510bcb11193	5/10/2003	Blue crab	Edible	4.51	J
University of Houston and Parsons (2006)	11193	040323bcb11193	3/23/2004	Blue crab	Edible	3.4	J
University of Houston and Parsons (2006)	11193	041027bcb11193	10/27/2004	Blue crab	Edible	14.3	J
University of Houston and Parsons (2006)	11193	041027bcb11193-dup	10/27/2004	Blue crab	Edible	8.65	J
University of Houston and Parsons (2006)	11197	040323bcb11197	3/23/2004	Blue crab	Edible	2.11	J
University of Houston and Parsons (2006)	11197	041028bcb11197	10/28/2004	Blue crab	Edible	8.05	J
University of Houston and Parsons (2006)	11200	020902bcb11200	9/2/2002	Blue crab	Edible	1.03	J
University of Houston and Parsons (2006)	11252	020829bcb11252	8/29/2002	Blue crab	Edible	1.52	J
University of Houston and Parsons (2006)	11252	020829bcb11252-dup	8/29/2002	Blue crab	Edible	1.94	J
University of Houston and Parsons (2006)	11252	021113bcb11252	11/13/2002	Blue crab	Edible	3.02	J
University of Houston and Parsons (2006)	11252	030512bcb11252	5/12/2003	Blue crab	Edible	2.14	J
University of Houston and Parsons (2006)	11252	040309bcb11252	3/9/2004	Blue crab	Edible	2.13	J
University of Houston and Parsons (2006)	11252	041026bcb11252	10/26/2004	Blue crab	Edible	12.1	J
University of Houston and Parsons (2006)	11258	020801bcb11258	8/1/2002	Blue crab	Edible	8.49	J
University of Houston and Parsons (2006)	11258	030430bcb11258	4/30/2003	Blue crab	Edible	2.9	J
University of Houston and Parsons (2006)	11261	020820bcb11261	8/20/2002	Blue crab	Edible	4.68	J
University of Houston and Parsons (2006)	11261	021025bcb11261	10/25/2002	Blue crab	Edible	4.36	J
University of Houston and Parsons (2006)	11261	030510bcb11261	5/10/2003	Blue crab	Edible	2.67	J
University of Houston and Parsons (2006)	11261	040323bcb11261	3/23/2004	Blue crab	Edible	3.27	J
University of Houston and Parsons (2006)	11261	041026bcb11261	10/26/2004	Blue crab	Edible	9.36	J
University of Houston and Parsons (2006)	11264	030506bcb11264	5/6/2003	Blue crab	Edible	2.98	J
University of Houston and Parsons (2006)	11264	040323bcb11264	3/23/2004	Blue crab	Edible	2.95	J
University of Houston and Parsons (2006)	11264	041021bcb11264	10/21/2004	Blue crab	Edible	7.08	J
University of Houston and Parsons (2006)	11265	040330bcb11265	3/30/2004	Blue crab	Edible	2.91	J
University of Houston and Parsons (2006)	11265	041021bcb11265	10/21/2004	Blue crab	Edible	6.5	J
University of Houston and Parsons (2006)	11270	020828bcb11270	8/28/2002	Blue crab	Edible	5.85	J
University of Houston and Parsons (2006)	11270	030506bcb11270	5/6/2003	Blue crab	Edible	5.98	J
University of Houston and Parsons (2006)	11272	020726bcb11272	7/26/2002	Blue crab	Edible	2.04	

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
University of Houston and Parsons (2006)	11272	030429bcb11272	4/29/2003	Blue crab	Edible	0.373	J
University of Houston and Parsons (2006)	11272	040415bcb11272	4/15/2004	Blue crab	Edible	1.69	J
University of Houston and Parsons (2006)	11273	020828bcb11273	8/28/2002	Blue crab	Edible	6.71	J
University of Houston and Parsons (2006)	11273	020828bcb11273-dup	8/28/2002	Blue crab	Edible	10.3	J
University of Houston and Parsons (2006)	11273	030429bcb11273	4/29/2003	Blue crab	Edible	2.31	J
University of Houston and Parsons (2006)	11273	040421bcb11273	4/21/2004	Blue crab	Edible	8.11	J
University of Houston and Parsons (2006)	11273	040421bcb11273-dup	4/21/2004	Blue crab	Edible	9.27	J
University of Houston and Parsons (2006)	11274	020730bcb11274	7/30/2002	Blue crab	Edible	3.65	
University of Houston and Parsons (2006)	11274	030430bcb11274	4/30/2003	Blue crab	Edible	1.78	J
University of Houston and Parsons (2006)	11274	040420bcb11274	4/20/2004	Blue crab	Edible	2.26	J
University of Houston and Parsons (2006)	11280	020828bcb11280	8/28/2002	Blue crab	Edible	5.41	J
University of Houston and Parsons (2006)	11280	020828bcb11280-dup	8/28/2002	Blue crab	Edible	4.06	J
University of Houston and Parsons (2006)	11280	030506bcb11280	5/6/2003	Blue crab	Edible	6.04	J
University of Houston and Parsons (2006)	11280	040401bcb11280	4/1/2004	Blue crab	Edible	6.6	J
University of Houston and Parsons (2006)	11280	041020bcb11280	10/20/2004	Blue crab	Edible	10.6	J
University of Houston and Parsons (2006)	11287	020825bcb11287	8/25/2002	Blue crab	Edible	3.16	J
University of Houston and Parsons (2006)	11287	020825bcb11287-dup	8/25/2002	Blue crab	Edible	10	J
University of Houston and Parsons (2006)	11287	030505bcb11287	5/5/2003	Blue crab	Edible	6.35	J
University of Houston and Parsons (2006)	11287	040401bcb11287	4/1/2004	Blue crab	Edible	5.84	J
University of Houston and Parsons (2006)	11287	041019bcb11287	10/19/2004	Blue crab	Edible	7.51	J
University of Houston and Parsons (2006)	11292	020911bcb11292	9/11/2002	Blue crab	Edible	1	J
University of Houston and Parsons (2006)	11292	030505bcb11292	5/5/2003	Blue crab	Edible	3.01	J
University of Houston and Parsons (2006)	11292	040403bcb11292	4/3/2004	Blue crab	Edible	0.959	J
University of Houston and Parsons (2006)	11292	041020bcb11292	10/20/2004	Blue crab	Edible	2.08	J
University of Houston and Parsons (2006)	11298	020729bcb11298	7/29/2002	Blue crab	Edible	5.8	
University of Houston and Parsons (2006)	11298	030430bcb11298	4/30/2003	Blue crab	Edible	5.76	J
University of Houston and Parsons (2006)	11298	040420bcb11298	4/20/2004	Blue crab	Edible	3	J
University of Houston and Parsons (2006)	11298	040420bcb11298-dup	4/20/2004	Blue crab	Edible	6.08	J
University of Houston and Parsons (2006)	11300	020909bcb11300	9/9/2002	Blue crab	Edible	4.32	J
University of Houston and Parsons (2006)	11300	030530bcb11300	5/30/2003	Blue crab	Edible	3.53	J
University of Houston and Parsons (2006)	11300	040416bcb11300	4/16/2004	Blue crab	Edible	1.97	J

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
University of Houston and Parsons (2006)	11302	020826bcb11302	8/26/2002	Blue crab	Edible	2	J
University of Houston and Parsons (2006)	11302	030511bcb11302	5/11/2003	Blue crab	Edible	2.39	J
University of Houston and Parsons (2006)	11302	040416bcb11302	4/16/2004	Blue crab	Edible	1.97	J
University of Houston and Parsons (2006)	11305	020814bcb11305	8/14/2002	Blue crab	Edible	1.45	J
University of Houston and Parsons (2006)	11305	030503bcb11305	5/3/2003	Blue crab	Edible	4.42	J
University of Houston and Parsons (2006)	11305	040422bcb11305	4/22/2004	Blue crab	Edible	1.87	J
University of Houston and Parsons (2006)	11347	020812bcb11347	8/12/2002	Blue crab	Edible	4.09	J
University of Houston and Parsons (2006)	11347	030502bcb11347	5/2/2003	Blue crab	Edible	2.63	J
University of Houston and Parsons (2006)	11382	020813bcb11382	8/13/2002	Blue crab	Edible	0.709	J
University of Houston and Parsons (2006)	11382	030502bcb11382	5/2/2003	Blue crab	Edible	2.86	J
University of Houston and Parsons (2006)	13309	020911bcb13309	9/11/2002	Blue crab	Edible	1.83	J
University of Houston and Parsons (2006)	13309	030512bcb13309	5/12/2003	Blue crab	Edible	1.56	J
University of Houston and Parsons (2006)	13336	020828bcb13336	8/28/2002	Blue crab	Edible	1.18	J
University of Houston and Parsons (2006)	13336	021022bcb13336	10/22/2002	Blue crab	Edible	2.83	J
University of Houston and Parsons (2006)	13337	020814bcb13337	8/14/2002	Blue crab	Edible	1.75	J
University of Houston and Parsons (2006)	13337	030523bcb13337	5/23/2003	Blue crab	Edible	2.47	J
University of Houston and Parsons (2006)	13338	020823bcb13338	8/23/2002	Blue crab	Edible	1.38	J
University of Houston and Parsons (2006)	13338	021022bcb13338	10/22/2002	Blue crab	Edible	3.98	J
University of Houston and Parsons (2006)	13338	040317bcb13338	3/17/2004	Blue crab	Edible	1.19	J
University of Houston and Parsons (2006)	13338	041102bcb13338	11/2/2004	Blue crab	Edible	2.57	J
University of Houston and Parsons (2006)	13339	020825bcb13339	8/25/2002	Blue crab	Edible	6.37	J
University of Houston and Parsons (2006)	13339	020825bcb13339-dup	8/25/2002	Blue crab	Edible	5.17	J
University of Houston and Parsons (2006)	13339	030504bcb13339	5/4/2003	Blue crab	Edible	9.22	J
University of Houston and Parsons (2006)	13340	020807bcb13340	8/7/2002	Blue crab	Edible	0.99	J
University of Houston and Parsons (2006)	13340	021022bcb13340	10/22/2002	Blue crab	Edible	2.05	J
University of Houston and Parsons (2006)	13340	030523bcb13340	5/23/2003	Blue crab	Edible	0.977	J
University of Houston and Parsons (2006)	13340	040309bcb13340	3/9/2004	Blue crab	Edible	1.97	J
University of Houston and Parsons (2006)	13340	041103bcb13340	11/3/2004	Blue crab	Edible	1.35	J
University of Houston and Parsons (2006)	13341	020816bcb13341	8/16/2002	Blue crab	Edible	0.927	J
University of Houston and Parsons (2006)	13341	030506bcb13341	5/6/2003	Blue crab	Edible	3.75	J
University of Houston and Parsons (2006)	13342	020824bcb13342	8/24/2002	Blue crab	Edible	5.08	J

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
University of Houston and Parsons (2006)	13342	021028bcb13342	10/28/2002	Blue crab	Edible	4.99	J
University of Houston and Parsons (2006)	13342	030510bcb13342	5/10/2003	Blue crab	Edible	3.2	J
University of Houston and Parsons (2006)	13342	040309bcb13342	3/9/2004	Blue crab	Edible	5.95	J
University of Houston and Parsons (2006)	13342	041028bcb13342	10/28/2004	Blue crab	Edible	11.1	J
University of Houston and Parsons (2006)	13343	020904bcb13343	9/4/2002	Blue crab	Edible	3.66	J
University of Houston and Parsons (2006)	13343	030510bcb13343	5/10/2003	Blue crab	Edible	5.02	J
University of Houston and Parsons (2006)	13344	020823bcb13344	8/23/2002	Blue crab	Edible	5.81	J
University of Houston and Parsons (2006)	13344	020823bcb13344-dup	8/23/2002	Blue crab	Edible	4.09	J
University of Houston and Parsons (2006)	13344	021027bcb13344	10/27/2002	Blue crab	Edible	5.32	J
University of Houston and Parsons (2006)	13344	021114bcb13344	11/14/2002	Blue crab	Edible	4.15	J
University of Houston and Parsons (2006)	13344	040318bcb13344	3/18/2004	Blue crab	Edible	5.05	J
University of Houston and Parsons (2006)	13344	041021bcb13344	10/21/2004	Blue crab	Edible	4.33	J
University of Houston and Parsons (2006)	13355	020818bcb13355	8/18/2002	Blue crab	Edible	2	J
University of Houston and Parsons (2006)	13355	020818bcb13355-dup	8/18/2002	Blue crab	Edible	2.32	J
University of Houston and Parsons (2006)	13355	030523bcb13355	5/23/2003	Blue crab	Edible	0.893	J
University of Houston and Parsons (2006)	13363	020817bcb13363	8/17/2002	Blue crab	Edible	0.81	J
University of Houston and Parsons (2006)	13363	021116bcb13363	11/16/2002	Blue crab	Edible	0.542	J
University of Houston and Parsons (2006)	13589	020817bcb13589	8/17/2002	Blue crab	Edible	0.948	J
University of Houston and Parsons (2006)	13589	020817bcb13589-dup	8/17/2002	Blue crab	Edible	1.27	J
University of Houston and Parsons (2006)	13589	030516bcb13589	5/16/2003	Blue crab	Edible	0.758	J
University of Houston and Parsons (2006)	14560	020830bcb14560	8/30/2002	Blue crab	Edible	4.09	J
University of Houston and Parsons (2006)	14560	030512bcb14560	5/12/2003	Blue crab	Edible	1.03	J
University of Houston and Parsons (2006)	14560	040309bcb14560	3/9/2004	Blue crab	Edible	1.97	J
University of Houston and Parsons (2006)	14560	041104bcb14560	11/4/2004	Blue crab	Edible	1.57	J
University of Houston and Parsons (2006)	15464	020817bcb15464	8/17/2002	Blue crab	Edible	0.352	J
University of Houston and Parsons (2006)	15464	021113bcb15464	11/13/2002	Blue crab	Edible	0.345	J
University of Houston and Parsons (2006)	15464	030512bcb15464	5/12/2003	Blue crab	Edible	0.676	J
University of Houston and Parsons (2006)	15908	020911bcb15908	9/11/2002	Blue crab	Edible	1.12	J
University of Houston and Parsons (2006)	15908	030522bcb15908	5/22/2003	Blue crab	Edible	0.856	J
University of Houston and Parsons (2006)	15908	030522bcb15908-dup	5/22/2003	Blue crab	Edible	0.556	J
University of Houston and Parsons (2006)	15979	020905bcb15979	9/5/2002	Blue crab	Edible	4.29	J

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
University of Houston and Parsons (2006)	15979	030523bcb15979	5/23/2003	Blue crab	Edible	2.97	J
University of Houston and Parsons (2006)	15979	040331bcb15979	3/31/2004	Blue crab	Edible	6.25	J
University of Houston and Parsons (2006)	15979	041021bcb15979	10/21/2004	Blue crab	Edible	8.05	J
University of Houston and Parsons (2006)	15979	041021bcb15979-dup	10/21/2004	Blue crab	Edible	14.4	J
University of Houston and Parsons (2006)	16213	020910bcb16213	9/10/2002	Blue crab	Edible	0.748	J
University of Houston and Parsons (2006)	16213	030512bcb16213	5/12/2003	Blue crab	Edible	0.824	J
University of Houston and Parsons (2006)	16496	020824bcb16496	8/24/2002	Blue crab	Edible	4.91	J
University of Houston and Parsons (2006)	16496	030510bcb16496	5/10/2003	Blue crab	Edible	4.07	J
University of Houston and Parsons (2006)	16499	020823bcb16499	8/23/2002	Blue crab	Edible	5.92	J
University of Houston and Parsons (2006)	16499	021024bcb16499	10/24/2002	Blue crab	Edible	3.16	J
University of Houston and Parsons (2006)	16499	040317bcb16499	3/17/2004	Blue crab	Edible	3.83	J
University of Houston and Parsons (2006)	16499	041108bcb16499	11/8/2004	Blue crab	Edible	4.82	J
University of Houston and Parsons (2006)	16618	020820bcb16618	8/20/2002	Blue crab	Edible	15.8	J
University of Houston and Parsons (2006)	16618	030505bcb16618	5/5/2003	Blue crab	Edible	9.71	J
University of Houston and Parsons (2006)	16618	040318bcb16618	3/18/2004	Blue crab	Edible	7.33	J
University of Houston and Parsons (2006)	16618	041102bcb16618	11/2/2004	Blue crab	Edible	6.54	J
University of Houston and Parsons (2006)	16622	020902bcb16622	9/2/2002	Blue crab	Edible	1.37	J
University of Houston and Parsons (2006)	16622	030522bcb16622	5/22/2003	Blue crab	Edible	0.482	J
University of Houston and Parsons (2006)	17970	020818bcb17970	8/18/2002	Blue crab	Edible	4.15	J
University of Houston and Parsons (2006)	17970	021024bcb17970	10/24/2002	Blue crab	Edible	2.13	J
University of Houston and Parsons (2006)	17971	020824bcb17971	8/24/2002	Blue crab	Edible	5.39	J
University of Houston and Parsons (2006)	17971	021028bcb17971	10/28/2002	Blue crab	Edible	5.94	J
University of Houston and Parsons (2006)	17971	021028bcb17971-dup	10/28/2002	Blue crab	Edible	6.11	J
University of Houston and Parsons (2006)	11092	020802hcf11092	8/2/2002	Hardhead catfish	Edible	0.396	J
University of Houston and Parsons (2006)	11111	020801hcf11111	8/1/2002	Hardhead catfish	Edible	3.46	J
University of Houston and Parsons (2006)	11111	030501hcf11111	5/1/2003	Hardhead catfish	Edible	3.28	J
University of Houston and Parsons (2006)	11193	020809hcf11193	8/9/2002	Hardhead catfish	Edible	13.2	J
University of Houston and Parsons (2006)	11193	030514hcf11193	5/14/2003	Hardhead catfish	Edible	5.82	J
University of Houston and Parsons (2006)	11193	041028hcf11193	10/28/2004	Hardhead catfish	Edible	15.1	J
University of Houston and Parsons (2006)	11193	041028hcf11193-dup	10/28/2004	Hardhead catfish	Edible	13.8	J
University of Houston and Parsons (2006)	11197	041028hcf11197	10/28/2004	Hardhead catfish	Edible	15.1	J

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
University of Houston and Parsons (2006)	11252	020826hcf11252	8/26/2002	Hardhead catfish	Edible	3.17	J
University of Houston and Parsons (2006)	11252	021024hcf11252	10/24/2002	Hardhead catfish	Edible	8.79	J
University of Houston and Parsons (2006)	11252	030516hcf11252	5/16/2003	Hardhead catfish	Edible	2.33	J
University of Houston and Parsons (2006)	11252	040309hcf11252	3/9/2004	Hardhead catfish	Edible	2.23	J
University of Houston and Parsons (2006)	11258	020801hcf11258	8/1/2002	Hardhead catfish	Edible	7.89	J
University of Houston and Parsons (2006)	11258	030428hcf11258	4/28/2003	Hardhead catfish	Edible	5.8	J
University of Houston and Parsons (2006)	11261	020823hcf11261	8/23/2002	Hardhead catfish	Edible	11.7	J
University of Houston and Parsons (2006)	11261	021026hcf11261	10/26/2002	Hardhead catfish	Edible	8.5	J
University of Houston and Parsons (2006)	11261	030510hcf11261	5/10/2003	Hardhead catfish	Edible	10.7	J
University of Houston and Parsons (2006)	11261	040324hcf11261	3/24/2004	Hardhead catfish	Edible	4.64	J
University of Houston and Parsons (2006)	11261	041027hcf11261	10/27/2004	Hardhead catfish	Edible	14.8	J
University of Houston and Parsons (2006)	11264	020820hcf11264	8/20/2002	Hardhead catfish	Edible	8.4	J
University of Houston and Parsons (2006)	11264	030515hcf11264	5/15/2003	Hardhead catfish	Edible	10.8	J
University of Houston and Parsons (2006)	11264	040402hcf11264	4/2/2004	Hardhead catfish	Edible	8.63	J
University of Houston and Parsons (2006)	11264	040402hcf11264-dup	4/2/2004	Hardhead catfish	Edible	6.85	J
University of Houston and Parsons (2006)	11264	041026hcf11264	10/26/2004	Hardhead catfish	Edible	13.8	J
University of Houston and Parsons (2006)	11265	040402hcf11265	4/2/2004	Hardhead catfish	Edible	6.64	J
University of Houston and Parsons (2006)	11270	020828hcf11270	8/28/2002	Hardhead catfish	Edible	5.53	J
University of Houston and Parsons (2006)	11270	030506hcf11270	5/6/2003	Hardhead catfish	Edible	10.6	J
University of Houston and Parsons (2006)	11270	030506hcf11270-dup	5/6/2003	Hardhead catfish	Edible	14.4	J
University of Houston and Parsons (2006)	11273	020830hcf11273	8/30/2002	Hardhead catfish	Edible	8.07	J
University of Houston and Parsons (2006)	11273	030429hcf11273	4/29/2003	Hardhead catfish	Edible	11.2	J
University of Houston and Parsons (2006)	11273	040421hcf11273	4/21/2004	Hardhead catfish	Edible	2.92	J
University of Houston and Parsons (2006)	11280	020828hcf11280	8/28/2002	Hardhead catfish	Edible	5.87	J
University of Houston and Parsons (2006)	11280	030506hcf11280	5/6/2003	Hardhead catfish	Edible	15.1	J
University of Houston and Parsons (2006)	11280	040402hcf11280	4/2/2004	Hardhead catfish	Edible	12.9	J
University of Houston and Parsons (2006)	11280	041021hcf11280	10/21/2004	Hardhead catfish	Edible	19.2	J
University of Houston and Parsons (2006)	11287	041028hcf11287	10/28/2004	Hardhead catfish	Edible	5.26	J
University of Houston and Parsons (2006)	11292	041020hcf11292	10/20/2004	Hardhead catfish	Edible	1.32	J
University of Houston and Parsons (2006)	13309	020830hcf13309	8/30/2002	Hardhead catfish	Edible	3.14	J
University of Houston and Parsons (2006)	13336	020827hcf13336	8/27/2002	Hardhead catfish	Edible	2.71	J

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
University of Houston and Parsons (2006)	13336	020828hcf13336-dup	8/28/2002	Hardhead catfish	Edible	0.784	J
University of Houston and Parsons (2006)	13336	021022hcf13336	10/22/2002	Hardhead catfish	Edible	2.83	J
University of Houston and Parsons (2006)	13337	020814hcf13337	8/14/2002	Hardhead catfish	Edible	2.78	J
University of Houston and Parsons (2006)	13337	020814hcf13337-dup	8/14/2002	Hardhead catfish	Edible	11.5	J
University of Houston and Parsons (2006)	13337	030528hcf13337	5/28/2003	Hardhead catfish	Edible	6.49	J
University of Houston and Parsons (2006)	13338	020823hcf13338	8/23/2002	Hardhead catfish	Edible	6.69	J
University of Houston and Parsons (2006)	13338	021022hcf13338	10/22/2002	Hardhead catfish	Edible	8.16	J
University of Houston and Parsons (2006)	13338	021022hcf13338-dup	10/22/2002	Hardhead catfish	Edible	3.68	J
University of Houston and Parsons (2006)	13338	040318hcf13338	3/18/2004	Hardhead catfish	Edible	4.61	J
University of Houston and Parsons (2006)	13338	041004hcf13338	10/4/2004	Hardhead catfish	Edible	1.83	J
University of Houston and Parsons (2006)	13339	020823hcf13339	8/23/2002	Hardhead catfish	Edible	6.69	J
University of Houston and Parsons (2006)	13339	020823hcf13339-dup	8/23/2002	Hardhead catfish	Edible	7.5	J
University of Houston and Parsons (2006)	13339	030504hcf13339	5/4/2003	Hardhead catfish	Edible	10	J
University of Houston and Parsons (2006)	13340	020807hcf13340	8/7/2002	Hardhead catfish	Edible	1.98	J
University of Houston and Parsons (2006)	13340	030528hcf13340	5/28/2003	Hardhead catfish	Edible	4.35	J
University of Houston and Parsons (2006)	13340	040309hcf13340	3/9/2004	Hardhead catfish	Edible	1.47	J
University of Houston and Parsons (2006)	13341	020809hcf13341	8/9/2002	Hardhead catfish	Edible	4.9	
University of Houston and Parsons (2006)	13341	030528hcf13341	5/28/2003	Hardhead catfish	Edible	2.33	J
University of Houston and Parsons (2006)	13342	020822hcf13342	8/22/2002	Hardhead catfish	Edible	6.21	J
University of Houston and Parsons (2006)	13342	021028hcf13342	10/28/2002	Hardhead catfish	Edible	2.65	J
University of Houston and Parsons (2006)	13342	030511hcf13342	5/11/2003	Hardhead catfish	Edible	12.9	J
University of Houston and Parsons (2006)	13342	040309hcf13342	3/9/2004	Hardhead catfish	Edible	5.26	J
University of Houston and Parsons (2006)	13343	020820hcf13343	8/20/2002	Hardhead catfish	Edible	6.48	J
University of Houston and Parsons (2006)	13343	030506hcf13343	5/6/2003	Hardhead catfish	Edible	9.67	J
University of Houston and Parsons (2006)	13344	020821hcf13344	8/21/2002	Hardhead catfish	Edible	6.27	J
University of Houston and Parsons (2006)	13344	021027hcf13344	10/27/2002	Hardhead catfish	Edible	10.6	J
University of Houston and Parsons (2006)	13344	040318hcf13344	3/18/2004	Hardhead catfish	Edible	12.3	J
University of Houston and Parsons (2006)	13344	041028hcf13344	10/28/2004	Hardhead catfish	Edible	5.4	J
University of Houston and Parsons (2006)	13355	020818hcf13355	8/18/2002	Hardhead catfish	Edible	2.52	J
University of Houston and Parsons (2006)	13355	030528hcf13355	5/28/2003	Hardhead catfish	Edible	4.84	J
University of Houston and Parsons (2006)	13363	020817hcf13363	8/17/2002	Hardhead catfish	Edible	1.76	J

Table B-1
Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
University of Houston and Parsons (2006)	13589	020817hcf13589	8/17/2002	Hardhead catfish	Edible	1.54	J
University of Houston and Parsons (2006)	13589	020817hcf13589-dup	8/17/2002	Hardhead catfish	Edible	1.23	J
University of Houston and Parsons (2006)	13589	030516hcf13589	5/16/2003	Hardhead catfish	Edible	0.788	J
University of Houston and Parsons (2006)	14560	020830hcf14560	8/30/2002	Hardhead catfish	Edible	1.5	J
University of Houston and Parsons (2006)	14560	030512hcf14560	5/12/2003	Hardhead catfish	Edible	16	J
University of Houston and Parsons (2006)	14560	040309hcf14560	3/9/2004	Hardhead catfish	Edible	4.89	J
University of Houston and Parsons (2006)	14560	041003hcf14560	10/3/2004	Hardhead catfish	Edible	1.21	J
University of Houston and Parsons (2006)	15464	020818hcf15464	8/18/2002	Hardhead catfish	Edible	0.697	J
University of Houston and Parsons (2006)	15908	020911hcf15908	9/11/2002	Hardhead catfish	Edible	2.88	J
University of Houston and Parsons (2006)	15908	020911hcf15908-dup	9/11/2002	Hardhead catfish	Edible	6.79	J
University of Houston and Parsons (2006)	15908	030528hcf15908	5/28/2003	Hardhead catfish	Edible	3.17	J
University of Houston and Parsons (2006)	15979	020905hcf15979	9/5/2002	Hardhead catfish	Edible	11.7	J
University of Houston and Parsons (2006)	15979	030529hcf15979	5/29/2003	Hardhead catfish	Edible	11.6	J
University of Houston and Parsons (2006)	15979	040331hcf15979	3/31/2004	Hardhead catfish	Edible	13.9	J
University of Houston and Parsons (2006)	15979	041026hcf15979	10/26/2004	Hardhead catfish	Edible	7.63	J
University of Houston and Parsons (2006)	16213	020911hcf16213	9/11/2002	Hardhead catfish	Edible	3.02	J
University of Houston and Parsons (2006)	16213	030512hcf16213	5/12/2003	Hardhead catfish	Edible	2.45	J
University of Houston and Parsons (2006)	16496	020821hcf16496	8/21/2002	Hardhead catfish	Edible	6.6	J
University of Houston and Parsons (2006)	16496	030511hcf16496	5/11/2003	Hardhead catfish	Edible	11	J
University of Houston and Parsons (2006)	16496	030511hcf16496-dup	5/11/2003	Hardhead catfish	Edible	11	J
University of Houston and Parsons (2006)	16499	020823hcf16499	8/23/2002	Hardhead catfish	Edible	4.84	J
University of Houston and Parsons (2006)	16499	020823hcf16499-dup	8/23/2002	Hardhead catfish	Edible	8.76	J
University of Houston and Parsons (2006)	16499	021024hcf16499	10/24/2002	Hardhead catfish	Edible	7.28	J
University of Houston and Parsons (2006)	16499	040318hcf16499	3/18/2004	Hardhead catfish	Edible	4.38	J
University of Houston and Parsons (2006)	16499	041029hcf16499	10/29/2004	Hardhead catfish	Edible	4.96	J
University of Houston and Parsons (2006)	16618	020819hcf16618	8/19/2002	Hardhead catfish	Edible	6.83	J
University of Houston and Parsons (2006)	16618	030505hcf16618	5/5/2003	Hardhead catfish	Edible	9.85	J
University of Houston and Parsons (2006)	16618	040318hcf16618	3/18/2004	Hardhead catfish	Edible	3.45	J
University of Houston and Parsons (2006)	16618	041003hcf16618	10/3/2004	Hardhead catfish	Edible	3.48	J
University of Houston and Parsons (2006)	17970	020818hcf17970	8/18/2002	Hardhead catfish	Edible	2.01	J
University of Houston and Parsons (2006)	17970	021024hcf17970	10/24/2002	Hardhead catfish	Edible	3.01	J

Table B-1

Historical Fish Tissue Data for Dioxins and Furnas as TEQ_{DF}[a]

Study	Location ID	Sample ID	Sample Date	Species (Common Name)	Tissue Type	Concentration (ng/kg ww)[b,c]	Qualifier
University of Houston and Parsons (2006)	17970	021024hcf17970-dup	10/24/2002	Hardhead catfish	Edible	5.49	J
University of Houston and Parsons (2006)	17971	020824hcf17971	8/24/2002	Hardhead catfish	Edible	3.77	J
University of Houston and Parsons (2006)	17971	021028hcf17971	10/28/2002	Hardhead catfish	Edible	8.43	J

Notes

J = estimated

U = undetected

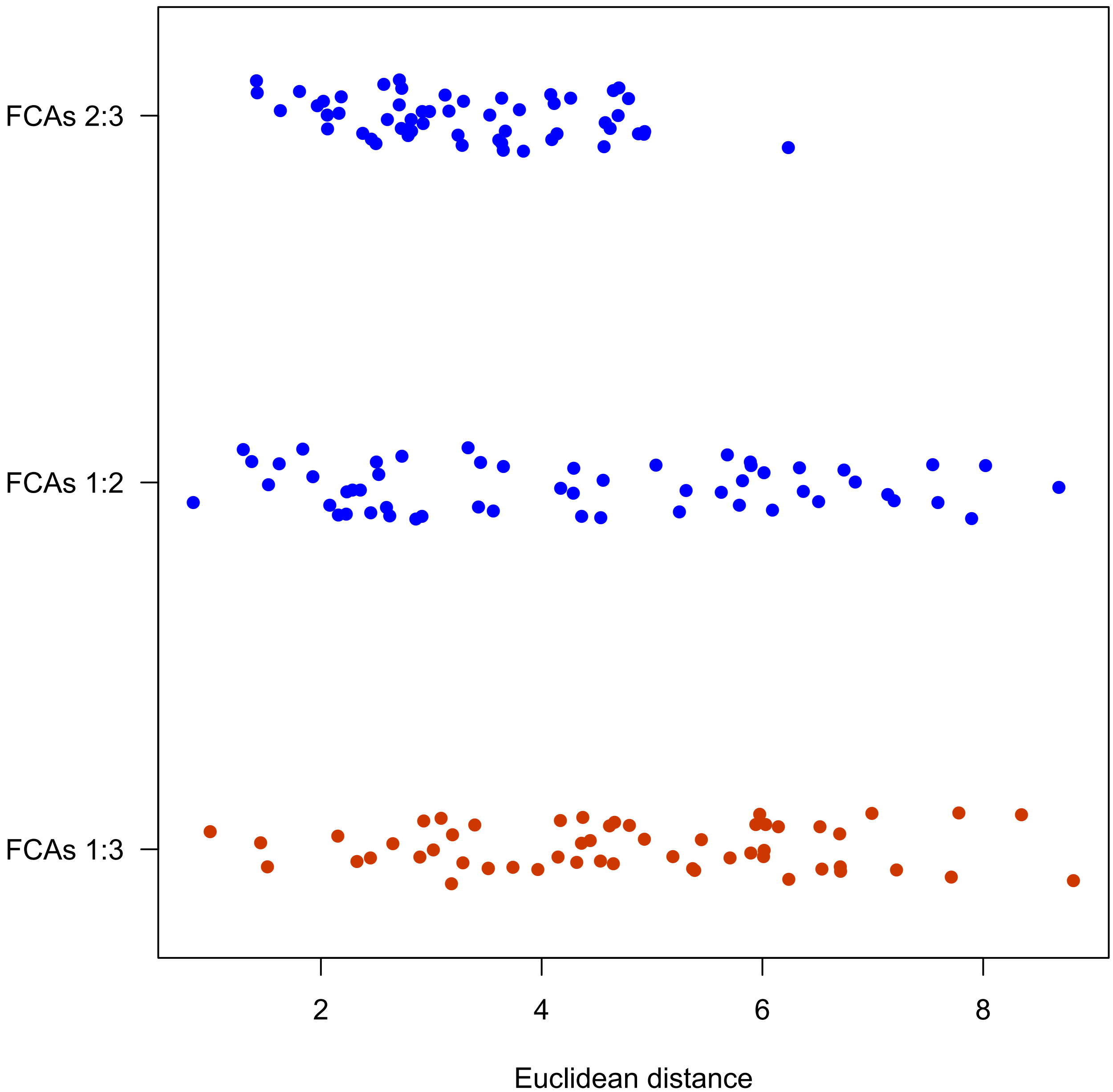
ww = wet weight

[a] Calculated with non-detects set at one-half the detection limit.

[b] The wet weight designation is assumed in some instances because this is the convention in reporting tissue data.

[c] Values reported here have been adjusted to a maximum of three significant figures for presentation purposes. The actual number of significant figures varies and more precise numbers are available in the database.

APPENDIX C
RESULTS FOR STATISTICAL COMPARISONS OF FCAS



Note:
COPC concentrations were centered and scaled prior to the distance calculation. Concentrations in FCAs 1 and 3 were statistically significantly different for mercury, so this comparison is shown in red. Concentrations in FCA 2 were not statistically different from either FCA 1 or FCA 2.

Figure C-1
Euclidean Distance between Hardhead Catfish Fillet Samples
in Pairs of FCAs for COPCs
SJRWP Exposure Assessment Memorandum
SJRWP Superfund/MIMC and IPC

Table C-1
Pair-wise Statistical Comparisons of FCAs: $COPC_H$s [a]

$COPC_H$	FCAs for Comparison			
		FCA1	FCA2	FCA3
Hardhead Catfish				
Arsenic	FCA1	1	0.7	0.03
	FCA2	0.7	1	0.1
	FCA3	0.03	0.1	1
BEHP	FCA1	NA	NA	NA
	FCA2	NA	NA	NA
	FCA3	NA	NA	NA
Cadmium	FCA1	1	0.9	0.4
	FCA2	0.9	1	0.2
	FCA3	0.4	0.2	1
Chromium	FCA1	1	0.6	0.8
	FCA2	0.6	1	0.8
	FCA3	0.8	0.8	1
Copper	FCA1	1	0.02	0.02
	FCA2	0.02	1	0.6
	FCA3	0.02	0.6	1
Mercury	FCA1	1	0.03	0.002
	FCA2	0.03	1	0.1
	FCA3	0.002	0.1	1
Nickel	FCA1	1	0.06	0.7
	FCA2	0.06	1	0.2
	FCA3	0.7	0.2	1
PCB-43Cong	FCA1	1	1.0	0.4
	FCA2	1.0	1	0.3
	FCA3	0.4	0.3	1
TEQ_{DF}	FCA1	1	0.2	0.6
	FCA2	0.2	1	0.3
	FCA3	0.6	0.3	1
Zinc	FCA1	1	0.2	0.09
	FCA2	0.2	1	0.3
	FCA3	0.09	0.3	1
Edible Blue Crab				
Arsenic	FCA1	1	0.9	0.05
	FCA2	0.9	1	0.03
	FCA3	0.05	0.03	1
BEHP	FCA1	NA	NA	NA
	FCA2	NA	NA	NA
	FCA3	NA	NA	NA
Cadmium	FCA1	1	0.2	0.006
	FCA2	0.2	1	0.4
	FCA3	0.006	0.4	1

Table C-1
Pair-wise Statistical Comparisons of FCAs: $COPC_H$s [a]

$COPC_H$		**FCAs for Comparison** FCA1	FCA2	FCA3
Chromium	FCA1	1	0.1	0.01
	FCA2	0.1	1	0.4
	FCA3	0.01	0.4	1
Copper	FCA1	1	0.3	0.6
	FCA2	0.3	1	0.7
	FCA3	0.6	0.7	1
Mercury	FCA1	1	0.0006	0.005
	FCA2	0.0006	1	0.04
	FCA3	0.005	0.04	1
Nickel	FCA1	NA	NA	NA
	FCA2	NA	NA	NA
	FCA3	NA	NA	NA
PCB-43Cong	FCA1	1	0.0008	0.002
	FCA2	0.0008	1	0.04
	FCA3	0.002	0.04	1
TEQ_{DF}	FCA1	1	0.009	0.0004
	FCA2	0.009	1	0.1
	FCA3	0.0004	0.1	1
Zinc	FCA1	1	0.2	1
	FCA2	0.2	1	0.5
	FCA3	1	0.5	1
Edible Clam				
Arsenic	FCA1	1	0.04	0.06
	FCA2	0.04	1	0.6
	FCA3	0.06	0.6	1
BEHP	FCA1	NA	NA	NA
	FCA2	NA	NA	NA
	FCA3	NA	NA	NA
Cadmium	FCA1	1	0.6	0.7
	FCA2	0.6	1	0.2
	FCA3	0.7	0.2	1
Chromium	FCA1	1	0.9	1
	FCA2	0.9	1	0.7
	FCA3	1	0.7	1
Copper	FCA1	1	0.009	0.01
	FCA2	0.009	1	0.3
	FCA3	0.01	0.3	1
Mercury	FCA1	1	0.7	0.06
	FCA2	0.7	1	0.3
	FCA3	0.06	0.3	1

Table C-1
Pair-wise Statistical Comparisons of FCAs: $COPC_H$s [a]

$COPC_H$	FCAs for Comparison			
		FCA1	FCA2	FCA3
Nickel	FCA1	1	0.004	0.01
	FCA2	0.004	1	0.6
	FCA3	0.01	0.6	1
PCB-43Cong	FCA1	1	0.04	0.01
	FCA2	0.04	1	0.7
	FCA3	0.01	0.7	1
TEQ_{DF}	FCA1	1	0.03	0.06
	FCA2	0.03	1	0.007
	FCA3	0.06	0.007	1
Zinc	FCA1	1	0.9	0.01
	FCA2	0.9	1	0.003
	FCA3	0.01	0.003	1

Notes

BEHP = bis(2-ethylhexyl)phthalate

$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessment

FCA = fish collection area

NA = not applicable, all samples were non-detect

TEQ_{DF} = toxicity equivalent for dioxins and furans

a - Statistical significance was evaluatated at an overall *p* of 0.05. For hardhead catfish and clam where there are nine detected $COPC_H$s, individual $COPC_H$s were evaluated at a *p* -value of 0.0056 based on the Bonferroni correction for multiple comparisons. For crab, where there are eight detected $COPC_H$s, individual $COPC_H$s were evaluated at a *p* -value of 0.006 based on the correction factor. Significant *p* -values are highlighted.

APPENDIX D
DETECTION FREQUENCIES FOR SEDIMENT, TISSUE, AND SOIL EXPOSURE UNITS

Table D-1

Detection Frequency in Sediment by Exposure Unit, Area North of I-10 and Aquatic Environment [a]

$COPC_H$	Beach Area A	Beach Area B/C	Beach Area D	Beach Area E
Dioxins/Furans				
TEQ_{DF}	5/5	10/10	7/7	17/17
Metals				
Arsenic	5/5	10/10	7/7	13/13
Cadmium	0/5	4/10	7/7	11/13
Chromium [b]	4/5	10/10	7/7	13/13
Copper	2/5	10/10	7/7	13/13
Mercury [c]	5/5	8/10	6/7	13/13
Nickel	1/5	10/10	7/7	13/13
Zinc	5/5	10/10	7/7	13/13
Polychlorinated Biphenyls				
TEQ_P	--	--	--	4/4
Sum of Aroclors	--	--	--	0/4
Semivolatile Organic Compounds				
Bis(2-ethylhexyl)phthalate	0/5	5/10	5/7	13/13

Notes

-- = Not available, $COPC_H$ not analyzed
$COPC_H$ = chemical of potential concern for human health
TCRA = time critical removal action
TEQ_{DF} = toxicity equivalent for dioxins and furans
TEQ_P = toxicity equivalent for dioxin-like PCBs

a - All beach areas were accessible under pre-TCRA conditions. Only Beach Area A is accessible to humans under post-TCRA conditions.
b - Available data are for total chromium.
c - Available data are for total mercury.

Table D-2
Detection Frequency in Fish and Shellfish by Exposure Unit, Area North of I-10 and Aquatic Environments

Tissue Type and $COPC_H$		
Hardhead Catfish - Fillet	**FCA1**	**FCA2/3**
Dioxins/Furans		
TEQ_{DF}	10/10	20/20
Metals		
Arsenic	10/10	20/20
Cadmium	2/10	2/20
Chromium [a]	5/10	8/20
Copper	10/10	20/20
Mercury [b]	10/10	20/20
Nickel	10/10	19/20
Zinc	10/10	20/20
Polychlorinated Biphenyls		
Total Congeners [c], TEQp	13/13	20/20
Semivolatile Organic Compounds		
Bis(2-ethylhexyl)phthalate	0/10	0/20
Crab - Edible	**FCA 1**	**FCA2/3**
Dioxins/Furans		
TEQ_{DF}	10/10	12/20
Metals		
Arsenic	10/10	20/20
Cadmium	10/10	20/20
Chromium [a]	9/10	8/20
Copper	10/10	20/20
Mercury [b]	10/10	20/20
Nickel	0/10	0/20
Zinc	10/10	20/20
Polychlorinated Biphenyls		
Total Congeners [c], TEQp	10/10	20/20
Semivolatile Organic Compounds		
Bis(2-ethylhexyl)phthalate	0/10	0/20
Clam - Edible	**FCA1/3**	**FCA 2**
Dioxins/Furans		
TEQ_{DF}	10/10	15/15
Metals		
Arsenic	10/10	15/15
Cadmium	10/10	15/15

Table D-2
Detection Frequency in Fish and Shellfish by Exposure Unit, Area North of I-10 and Aquatic Environments

Tissue Type and COPC$_H$		
Chromium [a]	10/10	15/15
Copper	10/10	15/15
Mercury [b]	10/10	13/15
Nickel	10/10	15/15
Zinc	10/10	15/15
Polychlorinated Biphenyls		
Total Congeners [c], TEQp	10/10	15/15
Semivolatile Organic Compounds		
Bis(2-ethylhexyl)phthalate	0/10	0/15

Notes

COPC$_H$ = chemical of potential concern for human health
FCA = fish collection area
TEQ $_{DF}$ = toxicity equivalent for dioxins and furans
TEQ$_P$ = toxicty equivalent for dioxin-like PCBs

a - Available data are for total chromium.
b - Available data are for total mercury.
c - Total congeners will be calculated as the sum of 43 PCB congeners, as described in Table 5.

Table D-3

Detection Frequency in Soils, Area North of I-10 and Aquatic Environment

$COPC_H$	Soils North of I-10	Soils North of I-10 $_{POST-TCRA}$ [a]
Dioxins /Furans		
TEQ_{DF}	46/46	6/6
Metals		
Arsenic	36/36	6/6
Cadmium	33/36	6/6
Chromium [b]	36/36	6/6
Copper	36/36	6/6
Mercury [c]	34/36	5/6
Nickel	35/36	6/6
Zinc	36/36	6/6
Polychlorinated Biphenyls		
TEQ_P	11/12	2/2
Sum of Aroclors	4/15	0/2
Semivolatile Organic Compounds		
Bis(2-ethylhexyl)phthalate	24/36	6/6

Notes

$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessmer
TCRA = time critical removal action
TEQ_{DF} = toxicity equivalent for dioxins and furans
TEQ_P = toxicty equivalent for dioxin-like PCBs

a - The areal extent of accessible soils is limited due to fencing consructed as part of the TCRA. Only sample locations SJTS028 to -031, TxDOT001, and TxDOT007 are accessible for the post-TCRA scenario.
b - Available data are for total chromium.
c - Available data are for total mercury.

Table D-4

Detection Frequency in Soils, South Impoundment Area [a,b]

Analyte [c]	**Surface Soils [d]**	**Shallow Subsurface Soils [e]**
Dioxins/Furans		
TEQ_{DF}	13/13	10/10
Metals		
Arsenic	10/10	10/10
Thallium	8/10	5/10

Notes

$COPC_H$ = chemical of potential concern to be addressed in the baseline human health risk assessment

EPC = exposure point concentration

TCRA = time critical removal action

TEQ_{DF} = toxicity equivalent for dioxins and furans

a - The TCRA did not impact the accessibility of soils in the south impoundment area. Sample size and frequency of detection shown are appliable to pre- and post-TCRA scenarios.

b - Data are from Phase I only. Phase II sampling will be conducted in the first quarter of 2012.

c - Selection of $COPC_H$s for the south impoundment area is in progress. Phase I soil investigation results for TEQ_{DF}, arsenic, and thallium exceeded risk-based human health screening levels protective of workers and may become $COPC_H$s. Therefore, the results for these analytes are shown here.

d - Surface soils include 0- to 6-inch and 0- to 2-foot samples. Surface soils will be used to calculate EPCs for trespassers.

e - Shallow subsurface soils include 6- to 12-inch samples. A depth weighted average for co-located samples will be used in the derivation of EPCs for workers.

APPENDIX E
CONTRIBUTION OF INDIVIDUAL DIOXIN CONGENERS TO TEQ_{DF} IN TISSUE

Table E-1
Percent Contribution of Each Dioxin and Furan to Total TEQ_{DF} among Site Tissue Samples

Analyte	Catfish Fillet			Edible Crab			Edible Clam		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
2,3,7,8-TCDD	82.9	96.6	93.2	16.1	77.7	45.3	33.1	80.4	60.5
1,2,3,7,8-PeCDD	0.528	7.12	2.59	1.6	43.2	13	0.0925	14.5	2.81
1,2,3,4,7,8-HxCDD	0.0299	0.5	0.125	0.146	2.13	0.965	0.0118	1.13	0.261
1,2,3,6,7,8-HxCDD	0.128	3.6	0.788	0.186	2.7	1.3	0.0138	1.96	0.401
1,2,3,7,8,9-HxCDD	0.0355	1.29	0.215	0.156	2.34	1.1	0.0124	1.26	0.324
1,2,3,4,6,7,8-HpCDD	0.039	0.725	0.109	0.0424	0.664	0.204	0.00919	7.02	0.509
OCDD	0.00325	0.0208	0.006	0.00526	0.22	0.035	0.00421	1.47	0.13
2,3,7,8-TCDF	0.204	3.29	1.56	1.57	31.4	17.5	15.3	46.6	32.4
1,2,3,7,8-PeCDF	0.00917	0.0873	0.0293	0.054	0.643	0.336	0.00869	0.368	0.0983
2,3,4,7,8-PeCDF	0.224	2.57	1.14	0.511	6.21	3.25	0.0855	3.51	0.937
1,2,3,4,7,8-HxCDF	0.0241	0.179	0.0683	0.121	1.82	0.804	0.0266	3.66	0.423
1,2,3,6,7,8-HxCDF	0.0237	0.172	0.0589	0.115	1.75	0.808	0.00768	1.86	0.318
1,2,3,7,8,9-HxCDF	0.0274	0.207	0.0753	0.139	2.42	0.991	0.0111	1.86	0.366
2,3,4,6,7,8-HxCDF	0.0254	0.192	0.0665	0.124	1.8	0.828	0.00831	1.64	0.344
1,2,3,4,6,7,8-HpCDF	0.00226	0.0188	0.00715	0.0148	0.304	0.1	0.00119	2.74	0.135
1,2,3,4,7,8,9-HpCDF	0.00308	0.0307	0.0102	0.0192	0.407	0.138	0.00167	0.296	0.0467
OCDF	0.000101	0.00418	0.000588	0.00136	0.0362	0.00799	0.0000318	0.366	0.0164

Notes

All values are percentages.
TEQ_{DF} = toxicity equivalent for dioxins and furans
TCDD/TCDF = tetrachlorinated dibenzodioxins/furans
PeCDD/PeCDF = pentachlorinated dibenzodioxins/furans
HxCDD/HxCDF = hexachlorinated dibenzodioxins/furans
HpCDD/HpCDF = heptachlorinated dibenzodioxins/furans
OCDD/OCDF = octachlorinated dibenzodioxins/furans

APPENDIX F
EPA COMMENTS RELATING TO THE DRAFT EXPOSURE ASSESSMENT MEMORANDUM, AND RESPONSES

Comment No.	Section	Page	Comment	Response to Comment - Proposed Revision
1	2	2-1	This section discusses exposure scenarios and whether or not they are considered potentially complete. The exposure pathways from surface water to both fishers, recreational visitors, and trespassers, have been deemed complete/minor and therefore only qualitatively assessed. The report shall clarify and expand the qualitative assessment of these pathways.	The qualitative discussion of pathways defined as potentially complete but minor to be included in the baseline human health risk assessment (BHHRA) will use information about the physical-chemical properties of the COPCs to inform the likely extent of their presence in certain exposure media. In addition, the likelihood, frequency, and intensity with which these pathways are anticipated to occur at the Site will be discussed. Text will be added to Section 2 that describes the manner in which minor pathways will be evaluated.
2	2; Figure 1	2-1	Organisms except invertebrates have been deemed complete/minor for porewater. However, if birds disturb sediment, then they could be exposed to quite a bit of porewater. To illustrate this point, consider wading birds that forage by grabbing food items from the sediment. Quantitative assessment of porewater shall be included for appropriate bird models.	The requested addition is not relevant to the exposure assessment for human receptors. No changes will be made to the Exposure Assessment Memorandum (EA Memo) to address this comment.
3	3.1	3-2	The text states that only TEQ_{DF}, arsenic, and thallium exceeded screening values in all surface and subsurface samples from Phase 1 sampling for the south impoundment. However, several Phase 1 PCB analyses exceeded the PCB industrial screening level of 740 µg/kg. For example, SB001 had 1310 µg/kg in one sample, and SB005 had 897 µg/kg in another. The text shall be revised to include PCB as exceeding the screening values.	The analysis summarized by the statement cited in the comment was performed consistent with Section 3.3 of the EA Memo, second paragraph: "Following USEPA (1989) guidance, for any $COPC_H$ detected at least once in a given medium, nondetected results that exceed the highest detected concentration will be excluded…." Thus, only detected concentrations of TEQ_{DF}, arsenic, and thallium from Phase 1 sampling for the south impoundment exceeded screening values. Total PCBs as the sum of Aroclors exceeded screening concentrations only when all Aroclors in a sample were below detection limits. According to the Data Management Plan (Appendix A to the RI/FS Work Plan), aggregate values such as total PCBs are *U*-qualified, or "nondetect," when all components of the aggregate are *U*-qualified. Only the *U*-qualified (non-detect) results for total PCBs were higher than the industrial screening level of 740 µg/kg. Because of the data treatment rules described in Section 3.3, these samples were not tabulated among those exceeding screening values. This clarification will be provided as a footnote in the final EA Memo.
4	3.1	3-2	This section identifies metals and inorganics as chemicals of potential concern for human health (also Table 1 of this document). However, this list is not completely reflective of the list identified in the Preliminary Site Characterization Report (July 2011 – Table 1-2). This section shall clarify the difference between the tables.	The difference between Table 1 of the EA Memo and the list of COPCs for the BHHRA provided in the Preliminary Site Characterization Report (PSCR) (i.e., the inclusion of thallium in Table 1 of the EA Memo) is clearly explained in Section 3.1, as follows: "Analyses of the sediment data according to methods described in the Sediment SAP are documented in the COPC Technical Memorandum (Integral 2011a) and resulted in determination of the final list of $COPC_H$s for the area north of I-10 and the aquatic environment (Table 1). Selection of $COPC_H$s for the south impoundment area is in progress. According to a comparison of the Phase 1 soil investigation results to risk-based human health screening levels protective of workers, only TEQ_{DF}, arsenic, and thallium exceeded screening concentrations in all surface and subsurface samples for which they were analyzed (Integral 2011c, Attachment A). **Although thallium is not a $COPC_H$ according to analyses of information for the north impoundment, it may be determined to be a $COPC_H$ for the south impoundment, and is therefore addressed in this memorandum and listed in Table 1."** (emphasis added) In addition, chemicals to be addressed only for ecological receptors were listed in the PSCR, but are not shown in the EA Memo, because the EA Memo addresses only human exposure analysis. A footnote will be added to the table for further clarification.

Comment No.	**Section**	**Page**	**Comment**	**Response to Comment - Proposed Revision**
5	3.2.2.3	3-8	This section discusses calculating a depth-weighted average soil concentration to represent the 0 – 12 inch interval. An explanation of how a depth-weighted average will be calculated shall be included.	An explanation of the approach for calculating a depth-weighted average will be added to Section 3.5, Exposure Point Concentrations.
7 [a]	3.4	3-11	This section discusses the exposure units for the risk assessment. The exposure units shall include sediments and aquatic environment outside of the 1966 perimeter (out to the "blue" preliminary site boundary). Although data indicate mostly very low levels, the risk is still undetermined for this area.	The exposure units for sediments discussed in Section 3.4.1 and shown in Figure 7 do include sediments outside of the 1966 perimeter of the northern impoundments. The samples included in the sediment exposure units reflect the sediments with which human receptors can reasonably be expected to regularly come into contact. Sediments in areas of the site submerged under deeper water are not likely to be regularly contacted by people. This concept is explained in Section 3.2.2.1 of the EA Memo. The basis for the definition of sediment exposure units was established by the DQOs for the sediment study, in Section 1.10.2.2 of the Sediment Sampling and Analysis Plan (SAP). The exposure units are consistent with the approved Sediment SAP and the analyses presented in the approved COPC Technical Memorandum. No revisions will be made to the sediment exposure units.
8	3.4 Table 6		The beach areas B/C and D shall be included as Post-TCRA sediment exposure units using the Trespasser scenario. A person climbing or otherwise going [through] the TCRA fence defines the perfect trespassing scenario. Also, the Post-TCRA soil exposure units shall be the same as for Pre-TCRA (with exception of the actual TCRA cap) for the Trespasser scenario.	The TCRA includes certain institutional controls limiting access to the area of the impoundment north of I-10. These institutional controls were considered when determining exposure units for the human receptors north of I-10. As stated in the EA Memo, the purpose of evaluating the post-TCRA scenario is to inform an analysis of costs and benefits associated with remedial alternatives. By necessity, the evaluation of the post-TCRA scenario recognizes that the fence is regularly maintained, and effectively limits access to the site.
9	3.4 Table 6		The Big Star property soil samples shall be an exposure unit separate from the soil samples actually in/on the waste pits. These two areas are clearly very different, both from an exposure and risk standpoint. A single exposure point concentration for these combined will significantly underestimate risk of the pits.	The risks associated with exposures to the material within the 1966 impoundment perimeter will be completely addressed. Note that the exposure units for sediments include "Beach Area E," which consists entirely of the area within the 1966 impoundment perimeter. Risks associated with exposure to the materials in this area will be adequately characterized.
10	3.4 Table 6		An appropriate exposure unit for water shall be included.	Please see response to Comment 1. Because direct contact with water is considered a minor pathway, it will not be addressed quantitatively.
11	3.4.2	3-12	The short paragraph on Post-TCRA tissue modeling is unclear. It states that tissue concentrations will be calculated using the statistical relationship between sediment and tissue data within the tissue exposure unit. Clarify whether sediment or tissue data (or both) from within the tissue exposure unit be used. Clarification is also needed as to how these calculations will be performed, and why such is appropriate.	The Post-TCRA modeling will rely on the relationships established in the Technical Memorandum on Bioaccumulation Modeling (Integral 2010c) and the PSCR (Integral and Anchor QEA 2012). Post-TCRA tissue concentrations will be calculated using sediment data for dioxin and furan congeners when a statistical relationship has been established. Clarification and additional detail on the approach to be used will be provided in the final EA Memo.
12	3.4.2.1.1	3-13	This section shall include an explanation and justification as to why analyses were conducted to assess data similarities and whether or not to pool data sets.	Data are pooled where possible to generate larger datasets, leading to more robust statistical analyses, as explained on p. 3-10 of the EA Memo. The analyses performed as described in Section 3.4 were presented in the DQOs for the tissue study, in Section 1.8.3 of the Tissue SAP (Integral 2010a). The explanation and rationale for the pooling of exposure units are included in Section 3.4 of the EA Memo.

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13	3.4.2.1.2	3-14	The calculation of site-specific Biota-Sediment Accumulation Factors (BSAFs) is important in order to be able to determine the acceptable sediment concentration to be protective of the human consumption of edible fish and shellfish. The calculation of BSAFs shall be included.	As noted in the response to comments on the draft PSCR, this topic will be addressed in the RI Report. The Technical Memorandum on Bioaccumulation Modeling (Integral 2010c) describes the circumstances under which BSAFs may be used to derive concentrations in sediment that are associated with specific tissue concentrations. The Tissue SAP (Integral 2010a) includes calculation of BSAFs among DQOs, in response to a request by USEPA comments on that document. Because the potential use of BSAFs is to identify acceptable sediment concentrations (as noted by the comment), the presentation of BSAFs should be in the RI Report, which will address preliminary sediment remediation goals in depth. Presentation of BSAFs requires this broader context.
14	3.5.1	3-20	These are distributions other than normal and log-normal. The report shall explain why no other distribution will be considered and why this is appropriate.	The text does recognize and explain how data with distributions other than normal and log-normal will be treated in a series of bullets at the end of Section 5.1. Clarifying text will be added to Section 3.5.1, second paragraph, third bullet to explain the treatment of such distributions, as shown below, in bold. "For **other or** unknown data distributions (i.e., those distributions that are not normal and cannot be transformed to a log-normal distribution), the arithmetic mean will be chosen as the CT EPC. The lesser of the 95UCL, based on an unknown distribution, and the maximum value for the dataset will be selected for the RM EPC."
15	4	4-1, Footnote 9	The following changes shall be made: change "evaluating" to "evaluated", and change "level exposure" to "level of exposure".	These typographical errors will be corrected.
16	4.1	4-6	This section discusses the selection of exposure frequency based on EPAs default factors and best professional judgment. This section shall clarify and state what exposure frequencies were chosen.	As described on p. 4-5 of this section, the exposure parameters are discussed in general terms in this section, and followed by more detailed explanations on the specific value and sources/justification for that value for specific receptors in section 4.2. The specific exposure frequency that will be used is included in Section 4.2.1.2.2 for receptors north of I-10, Section 4.2.2.2 for trespassers south of I-10, and Section 4.2.2.3 for workers south of I-10.
17	4.1	4-6	This section discusses the selection of exposure duration based on EPAs default factors and best professional judgment. This section shall clarify and state what exposure durations were chosen.	As described on p. 4-5 of this section, the exposure parameters are discussed in general terms in this section, and followed by more detailed explanations on the specific value and sources/justification for that value for specific receptors in Section 4.2. The specific exposure durations to be used are included in Section 4.2.1.2.1 for receptors north of I-10, Section 4.2.2.2 for trespassers south of I-10, and Section 4.2.2.3 for workers south of I-10.
18	4.1	4-8	EPA 2004 and 2011 are discussed as references for adherence factors for soil and sediment, but it is unclear which reference(s) were utilized in the final decision. This shall be stated as is done in other sections. This is apparent however, in Tables 8, 9, 10 and 11.	As described on p. 4-5 of this section, the exposure parameters are discussed in general terms in this section, and followed by more detailed explanations on the specific value and sources/justification for that value for specific receptors in Section 4.2. The specific adherence factors and their references are included in Section 4.2.1.2.2 for receptors north of I-10, and Section 4.2.2.3 for workers south of I-10. A reference will be added for the factors proposed for the trespasser for the area south of I-10 in Section 4.2.2.2 in the final EA Memo.

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19	4.1	4-8	**Fractions of Total Pathway Exposure to Soil and to Sediment:** It is stated that " To estimate exposure, it is therefore necessary to describe the portion of the dermal exposure pathway that will be attributable to soil and sediment." The text shall include that description. In addition, it was stated that "Information about the activities each receptor may engage in at the Site was used to assign these fractions." The text shall also provide information about these activities and how they were used to assign the fractions.	As described on p. 4-5 of this section, the exposure parameters are discussed in general terms in this section, and followed by more detailed explanations on the specific value and sources/justification for that value for specific receptors in Section 4.2. Text describing the factors considered in determining this fractional term are included in Sections 4.2.1.1 and 4.2.1.2.2. Clarification that the factors are based on professional judgment regarding the manner in which receptors are conceptualized to interact with soils and sediments will be provided in Section 4.2.1.1 of the EA Memo.
20	4.1	4-9	**Fraction of Total Daily Intake from Soil/Sediment That Is Site-Related:** It was stated that "Information about the Site was considered when determining the value for this factor for each receptor." The text shall provide that information.	As described on p. 4-5 of this section, the exposure parameters are discussed in general terms in this section, and followed by more detailed explanations on the specific value and sources/justification for that value for specific receptors in Section 4.2. Text describing the information that was considered for determining the factor for each receptor and exposure medium is in Section 4.2.
21	4.1	4-9	**Fraction of Total Fish or Shellfish Intake That Is Site-Related:** It is stated that, "Information about the Site was considered when determining this factor." The text shall provide that information.	As described on p. 4-5 of this section, the exposure parameters are discussed in general terms in this section, and followed by more detailed explanations on the specific value and sources/justification for that value for specific receptors in Section 4.2. Text describing the information that was considered for determining the factor for each receptor and exposure medium is in Section 4.2.1.2.3.
22	4.2.1.1	4-11	This paragraph states that "Information regarding fishing activities and consumption patterns at the Site is not available. In the absence of specific information on diet, exposures will be estimated separately under three scenarios: one scenario will consider finfish ingestion only, a second will consider crab ingestion only, and a third will consider clam ingestion only." Given the lack of site-specific information on fishing activities, this is a reasonable approach. However, to help reduce the expected uncertainty, scenarios shall be included that examine the possibility of exposure which does combine two or three of the fish, crab or clam.	Section 4.2.1.1 states that additional scenarios that include a mixed diet of two or more tissue types will be included in the uncertainty evaluation. Because of the absence of site-specific data on the composition of the diets of people who might collect seafood for consumption at the site, evaluation of a specific dietary scenario would be speculative. Focusing the risk assessment on single-tissue type exposures helps to quantify the types of tissues that are likely to result in the highest potential for exposure and simplifies calculation of an acceptable risk-based concentration in each tissue type. Evaluating a mixed diet in the uncertainty section helps frame each estimate of an acceptable concentration derived using single-tissue type diets. Clarification on the conservative nature of calculating risks associated with single tissue type diets that will be clarified in this section in the final EA Memo.
23	Table 7		Figure 1 denotes a Trespasser scenario for the northern impoundment. Such scenario shall also be included in Table 7.	Table 7 defines the scenarios that will be evaluated quantitatively in the risk assessment. Exposure pathways for the trespasser north of I-10 are considered potentially complete but minor, so the north impoundment Trespasser exposure and risk will be presented qualitatively and will therefore not be added to Table 7 (please see response to Comment 1).

Notes

a – Original Comment 6 was withdrawn per a communication from Gary Miller, U.S. EPA, to David Keith, Anchor QEA, LLC, dated May 10, 2012, and has been omitted from this response to comments. Original comment numbers on subsequent comments are retained herein.

References

Integral and Anchor QEA, 2012. Preliminary Site Characterization Report, San Jacinto River Waste Pits Superfund Site. Prepared for McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. Anchor QEA, LLC, Ocean Springs, MS, and Integral Consulting Inc., Seattle, WA. February, 2012.

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Integral, 2010c. Technical Memorandum on Bioaccumulation Modeling, San Jacinto River Waste Pits Superfund Site. Prepared for McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. Integral Consulting Inc., Seattle, WA. September 2010.

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